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SECTION OF GEOLOGY AND MINERALOGY

THE SCOPE OF MODERN SEISMOLOGY

By FRANK NEUMANN*

The scope of seismological interest has expanded enormously since the building of the first modern seismograph in Japan in the early eighties. Following the subsequent discovery that seismic waves traversed all parts of the earth's interior whenever a strong earthquake occurred, astronomers were anxious to check the density of the earth obtained from astronomical data against that obtained from seismological data. Many geologists were keen to know what light such data would shed on the interior structure of the earth, and a few physicists, mostly British and German, set to work to establish the theoretical framework on which much subsequent research was to be based. While activities in these fields marked the birth of modern seismological literature, a highlight of earthquake research not to be ignored was the great catalog of world earthquakes completed by Montessus de Ballore about the turn of the century.

Following the great California earthquake of 1906 and an even greater one the same year in Colombia and Ecuador, world-wide interest in seismology resulted in the establishment of many seismograph stations in all parts of the world and the organization of seismological societies at home and abroad to promote the systematic investigation of seismic phenomena. In the early twenties, the application of seismological principles to the exploration of oil-bearing structure ended a period of relative quiescence. At the same time, the advent of radio communication gave seismologists a badly needed tool for obtaining the required accuracy in measuring the speed of seismic waves. By 1940, about seventy seismological stations were operating in the United States, many of them under the guidance or supervision of central organizations sponsored by either the Federal Government or universities.

From the early seismographs, which often magnified the ground motion only about ten times (fairly adequate for seismic countries like Japan), the magnifying power has gradually been stepped up until now one particular type of instrument magnifies ground motion 100,000 times. This is about all that even a highly favorable site will stand without excessively magnifying the normal background activity caused by wind, microseisms or other disturbances.

With improved instrumentation, modern seismology is now mapping even weak earthquakes thousands of miles from the nearest seismograph station, whether they occur on land or beneath the sea. A

* U. S. Coast and Geodetic Survey, Washington, D. C.
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million earthquakes, large, small, and very feeble, are now known to occur every year. The great earthquake belts of the earth around the Pacific and across southern Eurasia have been mapped. The energy of earthquakes can now be estimated on a sound scientific basis, and it is found that one great earthquake may expend ninety per cent of all the energy represented in the seismic activity of a year. The discovery that earthquakes may originate as deep as 450 miles below the surface profoundly affected geological thinking as to how such stresses might be set up. The seismograms indicate that shearing stresses are at work at great depths as well as near the surface. It is considered that earthquakes generally represent sudden slipping of rock masses along faults, or the tilting of great crustal blocks, and modern research gives important new clues concerning the nature of these movements.

The structure of the earth as revealed by seismology pictures a great central core, a little more than half the radius of the earth in extent, which reacts to the transmission of seismic waves like a fluid. A crust of variable thickness and complex structure is also indicated. From laboratory tests on rock under high pressure and from geological considerations, it is possible to postulate the types of rock comprising the body of the earth structure.

Further investigation of earthquake phenomena and earth structure require more precise data on seismic wave speeds, especially if the variations in crustal and subcrustal structure are to be adequately clarified. The most important tool of the seismologist is the travel time chart which plots the travel times of many types of seismic waves against the epicenter-to-station distances. More stations and data are needed to outline the true nature of these curves, which reveal the structural details of the transmitting media.

The major unsolved problems of seismology are still the cause and prediction of earthquakes. The immediate causes, such as slipping along faults, block tilting, and volcanoes (for relatively weak shocks) are generally accepted. The explanation of trigger forces such as the attraction of heavenly bodies, earth tides, rainfall and other earthquakes must be accepted with some degree of credibility, but some of these would imply a periodic character to earthquake occurrence which does not exist. The ultimate cause is least understood, but is believed to be associated with the cooling of the earth with resulting shrinking, mountain building, and occasional rupture. The record is not sufficiently complete to explain exactly how erosion and sedimentation come into the picture. There may be slow movements of the semi-plastic magma beneath the crust, possibly slow-moving currents, but the nature of such movements is not clear. Radio activity may play an important role.

It is not possible to predict earthquakes on the basis of their periodicity, because they are not sufficiently periodic. Geodetic surveys which measure the accumulating ground strain prior to an earthquake seem to offer the most hopeful means of earthquake prediction. But definite patterns between ground movements and earthquakes must be developed before such prediction becomes practicable. On the Pacific Coast of the United States, such surveys are a part of the Government's program of earthquake research.

Where an intensive study of local earthquake activity is required, a group of local seismograph stations is necessary. Such groups have been established in central and southern California, Lake Mead, the central Mississippi Valley, along the St. Lawrence River and, to a lesser extent, in other areas. The objective of associating local activity with known fault patterns or other major crustal features has, in some cases, been successfully attained. At Hoover Dam, local shocks were found to be associated with the impounding of great masses of water above the dam. The spotting of active faults obviously has important engineering significance. In the category of regional studies must be

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included volcanic activity and rockbursts in mines.

The exploration of subterranean structure by controlled explosions and seismic measurement has been developed to a very high degree of efficiency by oil companies. Somewhat similar methods have been employed to study the structure of the continental shelf off the Atlantic seaboard and a portion of the Atlantic Ridge. They have been used by engineers to locate bedrock for the foundations of engineering structures such as dams, bridges, and even roads. In the arctic regions, they are used to measure the thickness of great ice sheets.

In the engineering-seismological field, the ground motions which damage buildings and other structures have been measured with special types of seismographs so that the engineer will know the nature of the earthquake forces to which engineering structures will be subjected. This difficult technical problem calls for special vibration studies and a still different type of instrumentation. The Government, through the U. S. Coast and Geodetic Survey, is taking an active part in such work.

Although the background activity at a seismological station is generally considered detrimental to good earthquake recording, there is a type of activity set up by meteorological conditions which has very practical value. These so-called microseisms, corresponding to ripples on a quiet pond, build up to large amplitudes on the approach of storms, especially at sea. Within the past few years, the Navy has been successful in detecting and tracking hurricanes in the West Indies and is at present extending the project to the western Pacific. Several types of microseisms of unknown origin require further study, but there is little doubt that in some way or other they are related to meterological conditions either near-by or distant.

SECTION OF BIOLOGY

THE BIOLOGICAL SYNTHESIS OF POLYSACCHARIDES

By EDWARD J. HEHRE*

The past ten years have seen the rapid development of the region between biology and chemistry that deals with the natural formation of higher sugars, especially the polysaccharides. For many years, physiologists had been discouraged from experimentation in this region by two erroneous ideas. The first was that the formation of large molecules is an "anabolic" process requiring the uptake of energy, so that the ability seemed likely to be restricted to living things; the second was that substances such as glycogen which are composed of glucose units are formed directly from glucose, possibly by reversal of the process of hydrolysis. However, during the past ten years, cell-free enzymatic synthesis has been achieved for four polysaccharide types, *i.e.*, amyloses, amylopectin- or glycogen-like polysaccharides, dextrans, and levans. For these reactions, no source of energy, apart from that resident in the substrate itself, is required; also, the substrate is not merely the repeating unit of the polymer product.

Enzymatic Synthesis of Polysaccharides of the Starch-Glycogen Class from Glucose-1-Phosphate. In 1937, Cori and Cori [1, 2] showed that the breakdown of glycogen in muscle extracts that takes place in the presence of phosphoric acid yields a non-reducing substance, which these authors isolated and identified as glucose-1-phosphoric acid. Shortly thereafter, Kiessling [3] and the Cori group [4, 5] independently showed that the phosphorolysis of glycogen was reversible, *i.e.*, cell-free phosphorylase obtained from yeast cells or from liver, when added to glucose-1-phosphate, caused the formation of polysaccharide material that had all the properties of glycogen. In 1940, Hanes [6] obtained phosphorylase from potatoes and peas, which brought about the formation of the amylose or unbranched component of starch from glucose-1-phosphate.

Subsequently, the Cori group and others have added a great deal of information on various aspects of the mechanism of phosphorylase action. It was early recognized, for example, that a trace of glycogen or starch was needed to start or "prime" the synthetic reaction, and the synthesis has been pictured as a process of building up upon a small amount of priming material. It is now known that small dextrin molecules may serve as primers, and also that different phosphorylases have different priming requirements. The following equation shows the conversion of glucose-1-phosphate to polysaccharide material of the amylose type, *i.e.*, the unbranched starch component that stains intensely blue-black with iodine:

$$\text{glucose-1-phosphate} + \text{terminal glucose unit of primer} \xrightleftharpoons{\text{phosphorylase}} \text{amylose} + \text{inorganic phosphate}$$

This reaction is brought about by the phosphorylase obtained from muscle, which tissue normally produces glycogen, and it is also brought about by the phosphorylase obtained from potatoes, which produce a starch that consists of one part of amylose and three parts of the highly branched polysaccharide, amylopectin. Attempts to explain these anomalies led to the discovery of a second enzyme

* Department of Bacteriology and Immunology, Cornell University Medical College, New York, N. Y. The work has been aided since 1944 by grants from the Sugar Research Foundation, Inc. This paper, illustrated by lantern slides, was presented at the meeting of the Section on March 8, 1948.

in animal and plant tissue that causes the formation of branches or cross-linkages of the 1:6 variety.[7-9] The formation of amylopectin- or glycogen-like polysaccharides may be expressed by the following equation:

$$\text{glucose-1-phosphate} + \text{terminal glucose unit of primer} \xrightleftharpoons[\text{cross-linking enzyme}]{\text{phosphorylase plus}} \text{glycogen or amylopectin} + \text{inorganic phosphate}$$

Certain bacteria also have a phosphorylase system apparently similar to that found in plant and animal tissues. We have recently found [10] that the diphtheria bacillus (*Corynebacterium diphtheriae*) as well as some streptococci will form starch from glucose-1-phosphate but not from other sugars. If it is true, as it now appears, that diphtheria bacilli but not the non-pathogenic diphtheroids produce starch from glucose-phosphate, that property may prove useful in the description and perhaps in the identification of those pathogenic bacteria.

The enzymatic synthesis of polysaccharides of the starch-glycogen class brought to solution a long-standing physiological problem. Because the substrate was a phosphorylated sugar, and because phosphorylated compounds are of such importance in carbohydrate metabolism in general, it was thought by some that phosphorylated sugars would prove to be essential for all polysaccharide synthesis. The following work on the synthesis of dextrans and levans by bacteria and by bacterial enzymes, however, has brought a different aspect to the problem.

Dextrans and Levans and their Formation from Sucrose by Bacteria. Sugar makers have observed the occasional formation of large and troublesome masses of slime or gum in their sugar factories for more than a century. The bacterial cause of this "viscous fermentation" of sucrose, as it came to be called, has been known since the time of Pasteur. Early workers, including the Dutch microbiologist Beijerinck and the Australian bacteriologist Grieg-Smith, recognized that the organisms responsible for slime formation in the sugar factories included *Leuconostoc mesenteroides,* a streptococcus-like bacterium from plants and the soil, as well as various aerobic sporulating bacilli from soil. They also recognized that slime formation occurred only when the bacteria were grown in the presence of sucrose and not when other mono- or disaccharides were substituted for sucrose.

The slimy materials formed from sucrose by those bacteria were long ago found to consist of two polysaccharides: one, a polymer of glucose units, called dextran; the other, a polymer of fructose units, called levan. Dextrans are high polymers of alpha D glucose units linked chiefly through 1:6 positions, but sometimes having branches of 1:6 chains linked to one of the No. 4 carbon atoms[11]; levans are polymers of fructofuranose units, linked in 2:6 positions.[11] Dextrans have a high positive optical rotation; levans are levorotatory. Neither dextrans nor levans are colored by iodine, nor are they hydrolyzed by the amylases that split polysaccharides of the starch-glycogen class. Dextran is more difficult to hydrolyze by acid than is starch; levan is much more readily split than either of these polyglucoses. One of the most interesting biological properties of dextrans and levans is their serological activity.[12, 13] The purified polysaccharides do not, to the best of our knowledge, cause antibody formation when injected into animals,[14] but purified dextrans and levans will give precipitation and complement fixation reactions when mixed with antisera obtained from animals that had been immunized with dextran- or levan-forming bacteria, provided the bacteria used for immunization had been

grown in the presence of sucrose. We have found [12, 15] that purified dextrans give serological cross-reactions with the sera of animals immunized with type 2, type 20, and in some instances type 12 pneumococci, even though these pneumococci do not form dextran and, when used for immunization, are not grown in the presence of sucrose.

TABLE 1 illustrates the serological reactions of a number of purified dextrans and levans isolated from sucrose broth cultures of different bacteria, including *Leuconostoc mesenteroides, Streptococcus bovis,*[16] and *Streptococcus* Lancefield group H,[17, 18, 15] all of which are dextran-forming varieties; also *Streptococcus salivarius* [16] and an aerobic sporulating *Bacillus* (strain N9), which produce levan. The dextran-reactive sera include anti-*Leuconostoc* serum and antisera against *Pneumococcus* types 2, 20 and 12. The levan-reactive serum was prepared by immunization with the levan-forming *Bacillus* (strain N9) grown in sucrose broth.[13] All of the dextrans (but neither levan) react in high dilution with the *Leuconostoc* and the *Pneumococcus* types 2 and 20 antisera. None reacts with antilevan serum or with various control sera. There is a minor, though definite, serological difference among dextrans with regard to their capacity to react with type 12 *Pneumococcus* serum.[12, 15] Some dextrans, like that from *Leuconostoc* strain A, react as strongly with the type 12 as with the types 2 and 20 antisera; other dextrans, like that from *Leuconostoc* strain B, react only to a slight extent with *Pneumococcus* 12; still other dextrans, derived from streptococci, do not react at all with this serum.[15] Purified levans react with the antilevan serum, but not with the dextran-reactive or control sera.

Particular interest attaches to the formation of dextrans and levans by nonhemolytic or *viridans* streptococci because of the possible application to the differentiation of those bacteria. Levan formation has been utilized in a redefinition of *Streptococcus salivarius,*[19] and the dextran-forming capacities of *Streptococcus bovis*[16] and of streptococci belonging to Lancefield group H[15, 17] may eventually aid in the description of those varieties. Dextran formation is a property also of a variety of streptococci found in the blood of approximately 40 per cent of patients with subacute endocarditis.[15] These streptococci, like dextran- or levan-forming bacteria in general, elaborate large quantities of the polysaccharide from sucrose, which capacity is fundamentally responsible for the success of experiments on the *in vitro* synthesis of dextrans and levans by enzymatic means.

TABLE 1

SEROLOGICAL PROPERTIES OF PURIFIED DEXTRANS AND LEVANS

Sucrose-derived polysaccharides	Antisera					
	*Leuconostoc**	*Pneumococcus*, type 2	*Pneumococcus*, type 20	*Pneumococcus*, type 12	*Bacillus*, sp., *N9**	Controls
Dextrans						
Leuconostoc, A	++++	++++	++++	++++	0	0
Leuconostoc, B	++++	++++	++++	+	0	0
Strep. bovis	++++	++++	++++	0	0	0
Strep. group *H*	++++	++++	++++	0	0	0
Levans						
Strep. salivarius	0	0	0	0	++++	0
Bacillus, sp., *N9*	0	0	0	0	++++	0

* Bacteria used for immunization grown in media containing sucrose.

TABLE 2

SEROLOGICAL COMPARISON OF PRODUCTS FORMED FROM SUCROSE BY STERILE ENZYME SOLUTIONS WITH PRODUCTS FORMED IN LIVING CULTURES

Strain of *Leuconostoc*	Reactivity *vs.* types 2, 20, and 12 anti-*Pneumococcus* sera			
	Enzyme-sucrose mixtures		Sucrose broth culture fluids	
	2 and 20	12	2 and 20	12
B	++++	+	++++	+
M	+++	0	++++	+
O	++++	+	++++	+
A	+++	+++	+++	+++
C	++++	++++	++++	++++
K	+++	+++	++++	++++

++++, precipitation with 1:5000 or 1:10000 dilution of the antigens.
+++, precipitation with 1:500 or 1:1000 dilution of the antigens.
+, precipitation with 1:10 or 1:20 dilution of the antigens.
0, no precipitation with 1:10 dilution of the antigens.

Synthesis of Dextrans and Levans by Enzymatic Means. Early workers, in particular Beijerinck,[20] had reported the production of gum-like material from sucrose by filtrates from various species of levan-forming sporulating bacilli. Their products were not, however, chemically or serologically identified, their filtrates not proved to be free of bacteria, and their results and ideas about synthetically active enzymes consequently were forgotten. In 1941, we were able to establish[21, 22] that sterile Barkfeld filtered extracts prepared from sucrose broth cultures of *Leuconostoc mesenteroides* brought about the *in vitro* synthesis of dextran when incubated with sucrose. Purified preparations of the dextran formed by the cell-free enzyme from sucrose were examined and found to be similar, both in serological and in chemical properties, to the dextran elaborated in sucrose broth cultures of the *Leuconostoc* bacteria from which the enzyme was derived. The possession of serological activity by the enzymatically synthesized dextrans is of special biological interest, and represents a feature that can be utilized to particular advantage in examining the question of the likeness between the polysaccharides synthesized by cell-free enzymes and the natural polysaccharides formed in living bacterial cultures.

An illustration of the excellent serological agreement between dextrans formed in enzyme-sucrose mixtures and those formed in living cultures is given in TABLE 2.[23] Sterile enzyme solutions were prepared from sucrose broth cultures of 6 strains of *Leuconostoc mesenteroides,* representing two serologically different types. The enzyme solutions were incubated with sucrose, and the mixtures then compared serologically with the supernatant fluids obtained from sucrose broth cultures of the 6 *Leuconostoc* strains.

The dextrans produced by the sterile enzyme-sucrose mixtures, like those from the bacterial cultures, reacted not only with antiserum of *Leuconostoc* but also cross-reacted with the antisera of types 2, 20 and 12 pneumococci. From TABLE 3, it is apparent that the enzyme-sucrose mixtures of 3 strains (B,M,O), like the culture fluids of those strains, had only slight capacity to react with type 12 in comparison with their capacity to react with types 2 and 20 *Pneumococcus* antisera; whereas the enzyme-sucrose mixtures of the remaining 3 strains (A,C,K), like the culture fluids of those particular strains, had as high a capacity to react with type 12 as with the types 2 and 20 antisera. Since the comparison was made by a test capable of detecting minor serological differences,

these results indicate the very close serological likeness between the material formed from sucrose by the cell-free enzymes and the material formed in living cultures of the strain of bacteria from which the enzyme had been derived.

The *Leuconostoc* enzymes were early found to be active upon sucrose and, to a slight extent, upon raffinose (galactosidosucrose), but are without effect upon glucose, invert sugar, or other common sugars.[21] The overall action of a *Leuconostoc* enzyme upon sucrose is illustrated in FIGURE 1. On incubation of enzyme and sucrose, polysaccharide formation is accompanied by the liberation of a reducing substance which has been identified as fructose. In the experiment of FIGURE 1, in which chemical measurements were made on all of the known components of the synthetic reaction, the conversion of sucrose to dextran and reducing sugar began without a noticeable lag period, proceded at a rate that diminished in an orderly way with time, and finally approached completion. Throughout the reaction, a regular relationship between the

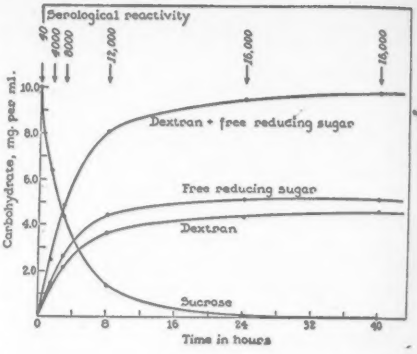

FIGURE 1.

dextran and the free reducing sugar was produced, associated at all periods with a corresponding loss of sucrose. The serological reactivity of the mixture, shown at the top of FIGURE 1, represents the highest dilution of the mixture that gave precipitation with a dextran reactive antiserum.

The relationships found in this and in many similar experiments suggest that the enzymatic reaction of dextran synthesis from sucrose may be expressed as:

$$\underset{\text{Sucrose}}{n\ C_{12}H_{22}O_{11}} \rightarrow \underset{\text{Dextran}}{(C_6H_{10}O_5)n} + \underset{\text{Fructose}}{n\ C_6H_{12}O_6}$$

The cell-free synthesis of dextran from sucrose by enzymes from *Leuconostoc mesenteroides* was confirmed by Stacey,[24] and the synthesis of levan from sucrose by enzymes from a soil bacterium (*Aerobacter levanicum*) established by Aschner and Hestrin.[25-28] The equation proposed for levan formation is analogous to that for dextran formation, *i.e.*,

$$\underset{\text{Sucrose}}{n\ C_{12}H_{22}O_{11}} \rightarrow \underset{\text{Levan}}{(C_6H_{10}O_5)n} + \underset{\text{Glucose}}{n\ C_6H_{12}O_6}$$

The formation of levan has many parallels with the synthesis of dextran. An outstanding difference is that levan formation proceeds as well from raffinose as from sucrose, whereas dextran formation is slight or absent from raffinose. The kinetic aspects of dextran and levan formation have been presented in several reports.[27-29]

An interesting point, hitherto unreported, is the capacity of *Leuconostoc* enzyme to convert very low concentrations of sucrose to dextran. Because of that capacity, and because it is possible to recognize very small amounts of dextran by serological means, it has been possible to devise a delicate semiquantitative test for sucrose. With it, sucrose can be recognized in as high dilution as one part in one hundred thousand, either alone or in the presence of large quantities of glucose or other sugars.

TABLE 3

SEROLOGICAL REACTIONS OF PRODUCTS SYNTHESIZED FROM SUCROSE AND RAFFINOSE BY THE CELL-FREE ENZYMES

Source of enzyme	Substrate	Highest dilution of enzyme-substrate mixture that gave precipitation in tests with different antisera: *Streptococcus salivarius* antiserum	*Bacillus N9* antiserum	Type 2 *Pneumococcus* antiserum	Control sera
Streptococcus salivarius	sucrose	1,000	1,000	5	
	raffinose	400	400	0	0
	other sugars†	10*	10*	0	0
	buffer solution	10*	10*	0	0
Bacillus N9	sucrose	1,000	1,000	0	0
	raffinose	1,000	1,000	0	0
	other sugars†	5*	5*	0	0
	buffer solution	5*	5*	0	0
Leuconostoc mesenteroides	sucrose	0	0	10,000	0
	buffer solution	0	0	10*	0

0 = no precipitation with 1:5 dilution of the antigen.
* Represents reactive material contained in the original enzyme solution, which did not increase in amount during the incubation of the test mixtures.
† Glucose, fructose, glucose plus fructose, maltose, lactose, trehalose, xylose or arabinose.

We have made experiments to determine whether the products synthesized from sucrose and raffinose by cell-free enzymes from levan-forming species would have serological properties like those of the levans produced in the living cultures. As shown in TABLE 3, cell-free enzymes from *Streptococcus salivarius* and from a sporulating levan-forming bacillus, when incubated with sucrose or raffinose, but not with other common sugars, gave rise to products that precipitated levan-reactive antisera. These products were serologically different from the dextran synthesized by *Leuconostoc* enzyme, shown at the bottom of the table. Some of the enzymatically synthesized polysaccharide was isolated from an incubated sucrose-*Streptococcus* enzyme mixture. It had chemical and serological properties like the levan produced in cultures of that particular strain of *Streptococcus salivarius.*

While equations expressing the overall reactions of synthesis of dextrans and levans from sucrose were obtained from early experiments, the exact mechanism by which these syntheses take place could be established only by further experiments. Analogy with the enzymatic syntheses of glycogen and starch raised the question of the participation of phosphorylated intermediates in dextran and levan formation. The possibility that glucose-1-phosphate might be a required intermediate in the conversion of sucrose to dextran was especially significant. Dextran is not too far removed structurally from polysaccharides of the starch-glycogen class and, furthermore, it was known that several kinds of bacteria, including *Leuconostoc mesenteroides,* can under certain conditions convert sucrose into glucose-1-phosphate and fructose. Doudoroff and his colleagues [39] showed that the reaction is reversible, and demonstrated the first biological synthesis of sucrose from glucose-1-phosphate and fructose through the action of "phosphorylase" from the bacterium *Pseudomonas saccharophila.*

In order to get data on the question of the role of phosphorus in dextran formation, a comparison was made [31] between *Leuconostoc* enzyme and potato phosphorylase in respect to their action upon

sucrose and upon glucose-1-phosphate. Polysaccharide-synthesizing enzyme from a *Leuconostoc* culture and from potatoes was incubated with 0.1 molar solutions of sucrose and of glucose-1-phosphate buffered at pH 5.6; control mixtures of the enzymes in buffer were included. After 4 hours, all the test mixtures were examined for evidence of polysaccharide formation (TABLE 4). The *Leuconostoc* enzyme, when incubated with sucrose, gave rise to abundant dextran formation with liberation of free fructose; the potato phosphorylase, when incubated with glucose-1-phosphate, caused the formation of abundant amounts of starch with the liberation of inorganic phosphate. In contrast, the *Leuconostoc* enzyme had no demonstrable action upon glucose-1-phosphate and the potato phospherylase had none upon sucrose. The lack of reactivity with glucose-1-phosphate on the part of the *Leuconostoc* enzyme, which was so reactive with the sucrose, can be taken as evidence that glucose-1-phosphate is not an intermediate substrate in the enzymatic synthesis of dextran from sucrose. The absence of any appreciable amount of phosphate in the system in which abundant dextran was formed suggests that the enzymatic synthesis of that polysaccharide does not require the mediation of any phosphorylated sugar substrate but occurs by a direct condensation of the sucrose in the way indicated by the equation given above. Evidence presented by Hestrin *et al.*[27] indicated that the enzymatic synthesis of levan from sucrose also does not require phosphorylated sugar intermediates.

TABLE 4

COMPARISON OF *Leuconostoc* ENZYME AND POTATO PHOSPHORYLASE IN RESPECT TO THEIR ACTION UPON SUCROSE AND UPON GLUCOSE-1-PHOSPHATE

Source of enzyme	Substrate	Properties of test mixtures incubated 4 hrs., 25°C. Appearance	Ppt. with alcohol	Serological reactivity	Color with iodine	Reducing sugar, mg./ml.	Inorganic phosphate, mg./ml.
Leuconostoc	sucrose	opalescent	++++	20,000	yellow	6.2	<0.001*
	glucose-1-phosphate	clear	0	40	yellow	0.1	0.03
	buffer control	clear	0	40	yellow	0.1	<0.001*
Potato	sucrose	clear	±	0	yellow	0.3	0.07
	glucose-1-phosphate	cloudy	++++	0	blue-black	0.3	6.4
	buffer control	clear	±	0	yellow	0.3	0.07

* No phosphate was detected by the Fiske-SubbaRow procedure or by the Deniges method, either before or after the mixture had been digested with sulfuric and nitric acids.

Our conclusion in 1943[31] was that the synthesis of dextran by *Leuconostoc* enzyme and the syntheses of starch and glycogen by the phosphorylases, though superficially different, nevertheless have a fundamental point of similarity. That is, in each instance, the substrate (sucrose or glucose-1-phosphate) contains the basic unit of the final polymer product in the form of a glycoside radical that is exceedingly easily split off by acids. The same relationship obtains in the enzymatic synthesis of levan, because here also the basic unit (fructose anhydride) is contained as a glycoside radical in the substrates (sucrose or raffinose) from which the levan is derived.

The activity of glucose-1-phosphate as a polysaccharide precursor thus would appear to depend upon structural features possessed also by the sucrose molecule, and not its being a phosphate "ester" as is com-

monly believed.* From that point of view, in contrast to the general assumption (see, for example, Cori [32] and Hassid, Doudoroff, and Barker [33]) that all polysaccharides of the starch-glycogen class arise from glucose-1-phosphate, sucrose might well be a precursor of starch or glycogen. An example of the possession of this capacity by sucrose was obtained early in 1946 when we found that certain gram-negative bacteria from the healthy throat do convert that disaccharide into a glycogen- or amylopectin-like polysaccharide.[34, 35]

Formation of Amylopectin-like Material from Sucrose by Neisseria *from the Pharynx.* The bacteria which have the capacity of forming amylopectin-like material from sucrose fall into the genus *Neisseria perflava,* and form a prominent part of the normal flora of the pharynx and nasopharynx. When they are grown on media containing sucrose, iodine-coloring material is produced; when grown on media containing common sugars other than sucrose, no such material is produced. The polysaccharide can be obtained in amounts as large as 3 to 5 grams per liter from cultures grown in 5 per cent sucrose broth. Chemical analyses show an amylopectin-like nature, clearly distinguishable from dextran. The polysaccharide is soluble in cold water to give colloidal solutions that are intensely opalescent and that stain maroon or purple-red with iodine. Both these properties are rapidly lost on treatment with saliva.

Data on the mechanism of the polysaccharide production were obtained in experiments such as the one shown in TABLE 5. When washed bacterial cells from glucose broth cultures were incubated with 0.05 molar solutions of various sugars in maleate buffer at pH 6.4, abundant amounts of polysaccharide were formed in the case of the test mixture which contained sucrose. Separate analyses were made on the sediments and supernatant fluids of the mixtures. The sucrose yielded considerable amounts of iodine-coloring polysaccharide in both the sediment and supernatant fluid fractions; glucose-1-phosphate yielded some but much less polysaccharide than the sucrose; and none of the other sugars tested (*i.e.*, glucose, glucose plus fructose, lactose, maltose, trehalose, α-methylglucoside, melibiose, raffinose or melezitose) yielded any demonstrable amount of polysaccharide.

TABLE 5

PROPERTIES OF INCUBATED MIXTURES OF *Neisseria* CELLS WITH VARIOUS SUBSTRATES

Substrate	Sediment		Supernatant fluid					
	Dark color with I_2	Polysaccharide, mg./ml.	Opalescence	Precipitate with 1.5 vols. alcohol	Dark color with I_2	Polysaccharide, mg./ml.	Free reducing sugars mg./ml.	Inorganic P, mg./ml.
Sucrose	++++	1.48	+++	+++	+++	0.61	2.75*	<0.01†
Glucose-1-phosphate	+	0.13	0	±	0	0.08	0.05	0.04
Other sugars‡	0	0.05	0	±	0	<0.06	—	<0.01†

* Fluid gave positive qualitative Ekkert (1928) test for free fructose.
† The total acid-soluble P was less than 0.05 mg per ml.
‡ Glucose, glucose + fructose, lactose, maltose, trehalose, α-methylglucoside, raffinose, melibiose, melezitose.

The data obtained in this experiment with washed bacterial cells furnished better evidence for the substrate specificity of the polysaccharide synthesis than could be obtained by experiments with growing cul-

* On the basis of physico-chemical considerations alone, Wolfrom and Pletcher[36] concluded in 1941 that glucose-1-phosphate resembles an acetal or glycosidic structure more closely than it does a true ester. Nevertheless, in spite of biological and chemical evidence, the terms Cori ester, 1-ester, ester bond, etc. continue to be used in connection with this substance.

tures, because the concentration of the bacterial agent and the pH were constant in all the test mixtures. The pronounced preference for sucrose distinguishes the polysaccharide formation by the neisseriae from the production of iodine-coloring reserve carbohydrates which has long been known to occur with various bacteria and fungi.

In the sucrose test mixture, in which abundant polysaccharide formation had occurred, there was no accumulation of inorganic phosphorus, and the total phosphorus concentration was very low. These points, together with the much greater yield of polysaccharide from sucrose in comparison to that from glucose-1-phosphate suggest that, when sucrose is the substrate, glucose-1-phosphate is not required as an intermediate substance. Decisive evidence was obtained in other experiments conducted in the presence of high concentrations of inorganic phosphate. In test mixtures in which the molecular concentration of inorganic phosphate was increased to 6 or 8 times that of the substrate, the formation of polysaccharide from glucose-1-phosphate was entirely suppressed, whereas the formation from sucrose was not inhibited.

In regard to the mechanism of the action upon sucrose, the points to be emphasized from TABLE 5 are: first, the free reducing sugar liberated into the fluid is fructose, as shown by the strongly positive Ekkert test; and, secondly, the amount of the reducing sugar corresponded reasonably well with the amount of polysaccharide in the fluid plus that in the sediment. These features suggest that the synthesis of amylopectin-like polysaccharide by the neisseriae is the same general type of reaction as the synthesis of dextran by *Leuconostoc* enzymes: that is, n molecules of sucrose are converted into n molecules of fructose plus a polysaccharide molecule containing n glucose anhydride units. It is of interest to speculate on whether or not similar conversions of sucrose to polysaccharides of the starch class may not have importance in plant metabolism.

Work is now in progress with a cell-free enzyme system, isolated from cultures of these *Neisseria,* which is capable of converting sucrose to glycogen- or amylopectin-like material. We have named this enzyme system *amylosucrase.* That term indicates the relationship to Hestrin's *levansucrase* and to the dextran-synthesizing enzyme or *dextransucrase.* It also emphasizes the distinction from the phosphorylase-plus-"cross-linking enzyme" systems obtained from plant and animal tissues, which convert glucose-1-phosphate to amylopectin or glycogen. In spite of the distinction, however, the synthesis of polysaccharides of the starch-glycogen class both by the neisseriae and by the plant and animal phosphorylases are fundamentally similar. The substrate (sucrose or glucose-1-phosphate) in each instance contains the basic unit of the final polymer product in the form of a glucoside radical that is exceedingly easily split off from the parent compound by acids but not by alkali. Phosphate is involved apparently in only one of the reactions and may not even be essential there. According to very recent work of Katz, Hassid and Doudoroff,[36] arsenate can replace phosphate in the breakdown of starch by potato phosphorylase. Glucose-1-arsenate, the expected product, has proved so labile that hydrolysis has so far prevented its isolation.

The ever widening study of reactions of polysaccharide formation is leading to increased understanding of other aspects of carbohydrate biochemistry. For example, our studies and those of Hestrin *et al.* have established the fact that sucrose enters reactions in which its glucoside and fructoside units are transferred, apparently without the mediation of phosphorylated compounds, to polysaccharides of several types (dextran, levan, amylopectin-like material). More recently, Doudoroff, Barker, and Hassid [37] have shown that the glucoside unit of sucrose also can be trans-

ferred to several disaccharides. All these studies, made with bacteria or with bacterial enzymes, show that sucrose is a versatile donor of its glycoside groups. If similar glycoside transfer reactions involving sucrose occur in plant or in animal tissues, we may be on the way toward understanding the role of one of the key sugars in nature.

What seemed ten years ago to be the end of a long-standing physiological problem (how glycogen is broken down and formed in the body) has proved to be but the beginning of a wide and rapidly advancing front in the field of biological reactions of carbohydrates.

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SECTION OF PSYCHOLOGY

THE SAMPLING PROBLEM IN PSYCHOLOGICAL RESEARCH

By HELEN M. WALKER*

Although a large proportion of the research studies in psychology involve the generalization from sample to universe, so that the procedures for drawing samples correctly is a problem of central importance in research work in psychology, and although in the last decade other fields such as biology, industry, agriculture, market research, opinion research, and governmental surveys have made very notable developments in the procedures for drawing samples scientifically, nevertheless there has been relatively little reference to these developments in psychological literature and one gains the impression that too few psychologists are aware of them. Unless the sample is drawn at random from a known universe or drawn at random within segments of that universe, or unless the observations can be assumed to be a random sample of a hypothetical universe, there is no way at all of drawing correct inferences from that sample to a larger population.

Empirical data were presented to illustrate the meaning of sampling distribution, the advantage of stratified random sampling, and the fallacies inherent in the ordinary use of pre-existent groups. Descriptions were given of the methods employed by the U. S. Census Bureau for obtaining a master sample of agriculture and a sample survey of unemployment.

The following implications for sampling in psychology may be noted:

(1) The overall size of a sample does not alone determine the sampling reliability of its statistics. By using a good design, a smaller sample can often be made to produce greater precision. A sample may be very large and still furnish no measure of precision and practically no reliable information.

(2) Sampling has become a highly technical business with a very large literature which cannot be safely ignored by the research worker.

(3) Certain kinds of studies, especially of the large survey type, are now almost out of bounds so far as individual research goes. A large-scale successful survey needs long preparation, a field staff, financial support, and a certain amount of highly technical information about sampling.

(4) In any survey, a random sample of refusals should be carefully followed up.

(5) Pre-existent groups should be used with the greatest caution. A preliminary survey might be made to see whether several such groups differ reliably as to the trait under consideration.

(6) In large-scale surveys, more use might be made of the punched cards on communities which can be obtained from the U. S. Bureau of Census.

(7) There is urgent need of a nation-wide master sample of persons which could be used in psychological, sociological, and educational studies of human beings. The promotion of such a sample would be an appropriate undertaking for the American Psychological Association.

* Teachers College, Columbia University, New York, N. Y. This paper was presented at the meeting of the Section on March 15, 1948.

SECTION OF ANTHROPOLOGY

A SURVEY OF NEAR-EASTERN ANTHROPOLOGY

By RAPHAEL PATAI*

The application to the Near East of those sciences which are called anthropological came at a relatively late date. The primary interest which first focused scientific attention on the Near East was that in the Bible, its background, historical and geographical setting, its archaeology and linguistic affinities. Accordingly, the whole area came to be designated and known by the name, "Bible Lands," and its history came to be looked upon from the viewpoint of what light it could shed upon the "sacred history" recorded in the Bible. All the countries which were the setting for any of the happenings related in the Bible were "Bible Lands," and the newly awakened interest, based upon the unquestioning belief in the "accuracy" of the Bible, proved to be a powerful stimulus for the study of these lands. The very specific archaeological investigation and a general sort of exploration of the present conditions prevailing in "Bible Lands" developed hand in hand.

The purpose of archaeological work was to unearth contemporary evidence as to Biblical history, while in the general exploration the emphasis was on the light thrown on the Bible by a study of the geography, natural conditions, fauna and flora of the "Bible Lands," and by the "manners and customs" of their present-day inhabitants. The results of these investigations soon found their way into Bible commentaries, and, due to them perhaps as much as owing to the textual and "higher" criticism of the Bible, a new and better understanding of the Holy Book was reached.

Scientific interest, once aroused, tends to continue, if not to increase. The studies begun for the Bible's sake were continued for their own sake and soon developed into separate sciences, each with a rapidly increasing body of knowledge of its own and with a corresponding tendency to specialization. Archaeology was the first to grow up into a full-fledged science in its own right, and excavations on a scale unprecedented even in Greece were soon being conducted in the "Bible Lands," with techniques more and more refined and methods of drawing conclusions more and more precise. The occurrences of successive layers in archaeological sites in Palestine and Mesopotamia became documents of utmost significance, the deciphering and interpretation of which with ever increasing accuracy enabled the science to trace back the beginnings of history in this region to the fifth millennium B. C.—that is, to a period by far preceding not only the first epochs of Bible history but even the traditionally accepted date of Biblical creation itself.

With the deciphering of the Egyptian hieroglyphics and the cuneiform scripts of ancient Mesopotamia, two new sciences were born, Egyptology and Assyriology, each of which today is an important and complex science in its own right. Beginning with a groping interpretation of inscriptional material which was brought to light, first, through chance findings and later through systematic excavations, the study of the languages and of material objects unearthed grew to complement each other more and more until a clear picture could be gained of the material culture and the political history of the respective countries, as well as of their religion, arts, sciences, literature, ideas: in brief, the culture of these countries, the peoples of which rose already in the very dawn of history to amazing heights of material as well as spiritual achievement.

* The Palestine Institute of Folklore and Ethnology, Jerusalem, Palestine, and Columbia University, New York, N. Y. This paper was presented at the meeting of the Section on March 22, 1948.

In another direction, the interest in the language of the Bible led to the study of the tongues related to it. Affinities with Babylonian and Assyrian, and even with Egyptian, were discovered and stressed, and the study of Arabic, Aramaic and other languages belonging to the Semitic family was pursued in addition to the study of Hebrew itself. The comparative study of the classical Semitic languages has reached a level equaled only by that of the Indo-European languages and, lately, written remains of entirely new languages have been discovered belonging both to the Semitic family, such as the language of the Ras Shamra-Ugarit tablets, and to non-Semitic languages such as that of the Hittites.

The disciplines referred to above are made use of by history which, drawing upon all of them, has by now succeeded in giving a fairly continuous picture of what happened in these lands of the East during a period some four times the length of European history. In all, it can be said that the studies pursued with real zeal and energy in the Near East for the last two or three generations have been historically oriented, a fact due to the very nature of this area in which culturally poor and apparently decadent peoples live in the shadow of magnificent ruins eloquently testifying to a long and glorious past.

We come now to survey the developments in the second trend of investigations which originated even earlier than the archaeological study of the "Bible Lands," namely, the general exploration of the present conditions prevailing in these countries. We have to state at the very outset that, if we expect to find here anything like the well-founded and systematically collected body of knowledge characteristic of the historical disciplines, we shall be keenly disappointed. For one reason or another, the study of the present conditions of the Near Eastern area has largely remained in the "Bible Lands" stage. Therefore, when speaking about the various fields of anthropological study in the present-day Near East, I shall have to dwell more often on problems which have yet to be solved, on tasks which have yet to be fulfilled, on fields that have yet to be explored, on approaches which have yet to be utilized—in brief, on what has yet to be done, rather than on what has already been done and achieved.

Let us begin with a brief and necessarily sketchy survey of the linguistic study of the modern Near East. A glance at the study of modern Arabic dialects will be sufficient to characterize the difference in the grade and extent of our knowledge of the classical Semitic languages on the one hand and of their modern derivatives on the other. Every aspect of classical Arabic, the language of the Koran, has long ago been thoroughly explored, so that our knowledge of its vocabulary, its grammar, linguistic affinities, and the like, leaves little if anything to be desired. Among the numerous modern Arabic dialects, on the other hand, there is not a single one which has been studied with any thoroughness even approximating this, while many of them are veritable *terra incognita* to this day. The domains of the Arabic dialects extend today, in addition to Arabia proper, over Iraq, Syria, the Lebanon, Palestine, Transjordan, Egypt, Tripolitania, Tunis, Algéria, and Morocco. The idioms spoken are so different that the inhabitants of different countries often cannot understand one another. Moreover, within one single country itself, various dialects exist, in accordance with either the geographical divisions of the country or the social stratification of its inhabitants, or both. In Palestine, small as it is, we have a good example of this double dialectic variegation: there is a marked difference between the language of the southern and the northern part of the country, and then, again, a still more marked difference between the dialects of the urban Arabs, of the settled villagers, the *fellahin*, and the nomadic *bedouin*. A systematic survey of all the

local Arabic dialects would be highly desirable, while, at a later stage, based on a survey of this kind, a comparative study of modern Arabic dialects could and should be made, somewhat on the lines of the famous *"Vergleichende Grammatik der semitischen Sprachen"* of Karl Brockelmann.

Arabic has influenced, in the Near East as well as in regions peripheral to it, a number of other languages, such as Aramaic, of which we shall hear more anon, Persian, and the Sudanic languages. Here, again, there is a field for the study of linguistic processes taking place when groups speaking different languages come in contact, and in the course of which one or both of them adopt certain elements from the language of the other.

While Arabic greatly expanded in the course of the last millennium, Aramaic, which in ancient days played the role of an international language in the whole Near East, lost its ground and is spoken today only by a few small and isolated groups. Apart from a few villages in the Lebanon, Aramaic is spoken only by the Nestorian Christians and by the Jews of Kurdistan. These so called New-Aramaic or Syriac dialects have been studied by Prym and Socin in Tur Abdin, and are being studied at present by my friend Dr. Joseph J. Rivlin among the Kurdish Jews. Comparative studies of the various New-Aramaic and Old-Aramaic dialects are still lacking.

As to Hebrew itself, it, too, has its new branches. I am referring not only to the revival of Hebrew in Jewish Palestine, where it has become, in the course of a single generation, a complete modern language capable of serving as a wholly adequate vehicle of modern literature, philosophy and science alike. Apart from this modern, and in part artificially, or rather consciously created Palestinian Hebrew, there is the modern survival of traditional Hebrew in the Jewish communities of Near Eastern lands, such as the Hebrew spoken by the Jews of Hadramaut, the very existence of whom became known only a short time ago.

We shall have to skip the Semitic languages spoken outside the Near East proper, such as the various Semitic dialects of Abyssinia, as well as the non-Semitic languages of the Near East itself, like the various Persian and Turkish dialects and only say, in conclusion of our brief presentation of the linguistic aspect of Near Eastern anthropology, that the vernaculars belonging to a number of major and minor groups have yet to be mapped out and investigated—a task which will require much patient and painstaking labor.

Before turning to the study of the Near Eastern peoples themselves, I should like to say a few words about the state of the geographical exploration of the area, for, of course, an adequate geographical survey is one of the prerequisites of any ethnological study. Our geographical knowledge of the Near East varies with its different subareas. On the one hand, there are countries such as Palestine, which have been surveyed as accurately and in as detailed a manner as any European country, so that on its large-scale map sheets one can find every smallest well or *tell*; while on the other hand there are large areas never yet visited by an outsider and represented on the map by a blank space. It was only a few years ago that Bertram Thomas traversed, on camel-back, one of these blank spaces in the *Rubʿ al-Khali,* the great South Arabian desert. As a result of his crossing, we now know that along a single route of some 700 miles connecting Dhufar on the southeastern shores of the Arabian peninsula with Qatar on its northeastern coast there are, for instance, some fifty wells, or rather waterholes, the existence of which alone makes human and animal life possible in the *Ar-Rimal,* The Sands, as the Empty Quarter is called by its own people. Thomas also supplied valuable information as to the flora, the fauna, and the peoples along the route he took, but many more such crossings in all directions

will be necessary before we can pronounce the geography of Southern Arabia even passably well known.

Leaving aside, of necessity, the more or less unknown areas of the Near East, let us now turn to the physical anthropology of its peoples. Again, we must preface our remarks with a warning as to the inadequacy of the available information. Anthropometrical measurements have been done only sporadically, and even where executed the individuals measured numbered only ten, twenty, or at the utmost forty. It is on such scanty factual material that the current classifications of the peoples of the Near East are based.

Taking physical anthropology in its widest sense, we should begin with a reference to the remains of fossil or prehistoric man in the area under survey. Since, however, these finds are very few in number and nowhere connect with unmistakable directness and clearness with the inhabitants of the area in historical times, I do not propose to say anything about the results arrived at or the problems arising from a study of human palaeontology in the Near East, but shall proceed instead directly to a brief discussion of the physical types of the inhabitants of our area in proto-historic and historical times.

To take head form first, it was found that the inhabitants of ancient and modern Mesopotamia, of ancient and modern Egypt, and of Northern Arabia were and are long-headed. The peoples inhabiting what can be called the northern belt of the Near East, stretching from Afghanistan and the Pamir in the east to Syria and Turkey in the west, as well as the peoples of Southern Arabia, as far as can be judged from the few measurements made, are decidedly round-headed. As one goes southwards in Syria, round-headedness gradually decreases, its place being taken by long-headedness. In the areas of the occurrence of both types in Syria, it is the *fellahin* and the urban population which are round-headed, while the *bedouin* are long-headed similarly to the bedouins all over the northern half of the Arabian peninsula. As head form, that is, the cephalic index, is taken to be one of the basic characteristics of races, the occurrence of these two different types in the Near Eastern area would alone be sufficient to make us aware of the fact that it was and is inhabited by peoples showing at least two different physical types. The two types, however, show a number of additional differences. The northern belt, stretching, as already mentioned, from Afghanistan and the Pamir westwards to Turkey, is the home of the so-called Armenoid type which is characterized, in addition to brachycephalism, by a flat occiput, lofty head, long face with a prominent aquiline nose. This type, or one very similar to it, occurs also among the South Arabs, who, however, according to Keith and Krogman,[1] are only half Caucasian, the other half of their features pointing decidedly to Hamitic (or Dravidian) affinities. Among these traits let us mention the very dark, almost black complexion, black fuzzy hair, chin tufts, small body, and certain facial features which are reminiscent of the peoples of the neighboring parts of Africa (Somali, Danakil, Hadendoa) and the Egyptians throughout nearly eight millennia.

The inhabitants of the southern shores of Arabia (the Yemen, the Sheher, and Muscat) form, as it were, connecting links between the round-headed South Arabs on the one hand and both the long-headed North Arabs and the long-headed Hamites on the other.

The North Arabs, occupying the territory between the South Arabs and the northern belt referred to above, are distinctly Semitic-Caucasian. The nomads inhabiting Mesopotamia, Syria, Palestine, Transjordan, and the northern half of the Arabian peninsula are long-headed. In stature, they are taller than the southerners. In pigmentation, it is only in northern

[1] See Appendix to **B. Thomas.** Arabia Felix: 319. New York. Scribner's. 1932.

Syria that a small proportion of blonds appears, though in general the north is lighter brown than the south.

In North Africa, the Berbers, mostly sedentary and agricultural, were the ancient inhabitants and to this day are the majority. They are of medium stature, very light brown in skin color, and brunet in hair and eye color. Interesting enough is the presence of a blond element, constituting in some places up to 12 per cent. Head form, though showing considerable variations, seems to be dolichocephalic in the fundamental type. On this substratum, the Arab type has been imposed following the Mohammedan conquest in the 12th and 13th centuries.

From the foregoing, it will be clear enough that, when speaking of the Near East, I am referring to the countries of the North African belt, to the Arabian peninsula and the territories adjoining to the north and the east of it. I think I should mention that it is by no means generally accepted to designate these lands, precisely, by the name "Near East." You will often find that the western part of North Africa is excluded. The term "Near East" itself is frequently discarded for the newer term "Middle East," which became fashionable in the course of World War II, and which is often understood to comprise an even wider area than the one indicated above. Seeing that there are such differences of opinion as to the extent of the area, in addition to the variety in the physical types of the peoples inhabiting it and in the languages spoken by them, I think it would be timely to explain what considerations seem to justify our treating this great expanse of lands as one single unit, and in what respects traits making for unity can be discerned in it.

Let us take a marked natural characteristic first. This entire area is subdivided into two very distinct geographical types: a region which is mediterranean in character with long, hot, and rainless summers, rainy, temperate winters, and a natural vegetation ranging from grass to open deciduous forests; and a region of deserts with great extremes of temperature, almost no rain at any season, and a very scanty vegetation of low grass and drought-resistant bushes. The dividing lines between the desert and the cultivated land, or the "sown," as it will be hereafter referred to, which runs along the entire Near Eastern area, must of course not be imagined to be anything like a clear-cut boundary. As a rule, there is a semi-desert or steppe belt of varying width between the true desert and the true sown, and, owing to the presence of this belt, parts of which can be swallowed up by either side, the borderline between the desert and the sown is neither definite nor constant, but is liable to shift forward or backward yielding to prolonged droughts or to abundant rains, and equally to population pressure exerted on it by the nomads of the desert or the agriculturists of the sown.

With the mention of the nomads and the agriculturists, we have reached a second general characteristic of the entire Near Eastern area: just as each Near Eastern country comprises both desert and sown, so its population is composed of both nomadic and settled elements. The desert has been for uncounted centuries, one may even say, millennia, the home of various types of pastoral nomads. The common characteristics of nomadic life all over the Near East, as far as can be generalized from the very inadequate information available, are: animal husbandry with a reliance mainly on the camel as a means of transportation, source of food (camel milk), supply of raw material for hair-tents, clothes, leather vessels and trappings; seasonal wandering with the herd within a certain territory, in the dry season near the steppe and the settled land, in the rainy season far out into the heart of the desert; tribal organization with a sheik at its head, collective responsibility expressed in such institutions as the blood-feud, raiding and hospitality (the law of sanctuary);

and a preference for the desert with its precarious but free life and a contemptuous attitude towards the "sown" with its relatively greater security coupled with the compulsion of unceasing, toilsome labor. The *bedouin* have a great familiarity with nature, the sands, the sky, the stars, the flora and the fauna, and show both in their physique and in their mentality a remarkable degree of adaptation to the unparalleled harshness of desert life.

These traits, to be sure, are found in a pronounced form only among the true nomads, that is, the camel-bedouins, who actually spend a great part of the year far away in the desert, cut off from any contact with settled people; who often have to traverse great distances over waterless sands or stones in search of pastures, or wells, or herds, or in pursuit of or retreat from an enemy. Among what we may call the half-bedouins, whose main possession are not camels but sheep and goats, one finds only rudiments of these characteristics. Owing to the inability of the flock to cover great distances, these semi-nomads have to remain near the settled lands even in the rainy season, mostly within the steppe-belt or the fringes of the desert which turn green after the first rains. Their limited mobility, their closer contact with agriculturists, the very difference between tending camel-herds and sheep or goat flocks, all these resulted in the semi-bedouins' taking, as it were, an intermediate position between the true nomads and the settled population.

To visualize the relative importance of the desert and the sown on the one hand and of the settled and the nomadic population on the other, it will be well to mention here that, while the cultivated land can be estimated as constituting about 10 per cent of the whole area of the Near East, it supports about 90 per cent of the entire population of the area. The demographic picture of the Near East thus shows a large, fairly dense agricultural settled population occupying a small percentage of the entire area on the one hand, and on the other a small minority of pastoral nomads scattered over the vast expanses of the desert.

Now, as to the settled population of the Near Eastern area, it again is composed of various elements. There are, first of all, the agriculturists, the *fellahin,* or peasants, living in village communities largely similar to one another all over the Near East, though of course showing local variations in conformity with the geographical and climatic conditions, as well as with religious and ethnic differentiation. A village in the mountains of Kurdistan is very dissimilar to one on the banks of the Upper Nile which, again, will be unlike one along the Moroccan coast. Likewise, a Christian village in the Lebanon, a Moslem village in Syria, and a Druz village in the Jebel Druz will each have its own peculiar characteristics not shared with the others. The building material of the Near Eastern village is stone in the mountains, mud in the plains, reed in the marshes, and palm-leaves in the deep south. The stone houses, for instance, are everywhere one or, rarely, two-storied buildings with few and small windows, flat or vaulted roofs; they are surrounded by dusty or muddy backyards with low dividing fences. The village well is mostly outside the village and often at a lower level. The presence of a village makes itself felt from a distance owing to the acrid smell of burnt dung. In contrast to the *bedouin* camp in which the tents are pitched at a fair distance from one another, the village is a compact and tightly packed cluster of houses or huts, with narrow, uneven, and winding passages of communication left open between them in the most haphazard manner. Surrounding the village are its lands, extensively cultivated and, apart from the neighborhood of the great rivers, such as the Nile, but rarely artificially irrigated.

The inhabitants of the village are *fellahin,* cultivators. But while in a

bedouin tribe each and every family subsists on animal husbandry, the villages have, in addition to their bulk of agriculturists, also a few artisans, such as a cobbler, a blacksmith, a weaver or a mason, as well as other specialists such as a teacher, some other religious persons, and the like. Social stratification goes hand in hand with occupational specialization, so that in most villages one finds landowners, tenants, and hired hands, each occupying quite a definite rung of his own in the scale of social positions.

In the *bedouin* tribe, the families of which traditionally trace back their descent to a common, often eponymous or mythical ancestor, every man is equal; the power vested in the sheik of the tribe is yielded to him voluntarily and he is expected to act always with an eye to the interests of the tribe as a whole. Ownership of property does not play a considerable role in the determination of personal status—wealth, reckoned in heads of camels, can quickly dwindle in consequence of a few seasons of drought, or even more suddenly disappear in the wake of resourceful enemy raiders; or, again, relative poverty can within a few days turn into wealth in consequence of a single lucky raid. What determines, therefore, the status of a man are his personal courage and valor, or, in later age, wisdom in counsel and, the greatest blessing of all, a large number of sons.

In the settled population, the situation is quite different. Here, the village is the social unit, the families of which may or may not be related to one another. The social status of the individual is strongly influenced by his wealth, reckoned in land and money. The head of the wealthiest family is often recognized by the village *de facto,* and by the government *de jure,* as head of the village. As such he divides, even in the best case, his efforts between three aims: the furtherance of his own wealth, of that of the village, and of the interests of the government. In many cases, especially in Palestine, Syria, and the Lebanon, the land of entire villages is the property of absentee landlords, to whom the *fellah* has to pay rent in crop or cash.

To give a general characterization of Near Eastern village life is a much more difficult task than in the case of the nomads, which we have attempted above. First of all, there is the marked difference between the pronounced heterogeneity of the villagers as against the relative homogeneity of the nomads. The desert is largely the same throughout the entire Near Eastern area, and so are its sons, the nomadic camel-herders. The villagers, on the other hand, are as different from each other as are their villages. The inhabitants of villages perched amid the wild mountains of Kurdistan with their rough climate are rugged, often ferocious people, given to hard drinking, forced to fight nature constantly and inclined to fight each other on every occasion. The villages of the Kurdish mountain tracts are often impenetrable natural strongholds, independent of any outer rule, subject even at the utmost only very nominally to the government of the country to which they are reckoned to belong politically. A Kurdish village is a self-relying and self-sufficient unit socially, politically, and economically alike. They are, in fact, settled tribal bases, and as such much nearer in many respects to the nomadic tribes of the desert than to the *fellahin* of the villages bordering upon the desert.

How different from this proud, unbridled, and self-willed folk are the *fellahin* living in the villages of Upper Egypt! Klunzinger,[2] who knew Upper Egypt before the processes of change set in, having lived there in the sixties and the seventies of the last century, says of the *fellah* of that country, "Though belonging to the very lowest rank, he knows how to conduct himself with propriety, almost with polish, in society; he may be often rough, but he is never rude and boorish, a main reason for this being that he never

[2] Klunzinger, C. B. Upper Egypt: 125. London. 1878.

gets drunk. Compliments flow from his eloquent tongue till they verge on flattery and falsehood. He is entertaining, witty, full of fancy, good-humoured in ordinary intercourse if at all well treated; but he is mendacious, deceitful, avaricious, fond of begging, and even thievish, when there is any question of *meum* and *tuum*. Patiently, like the camel, he bears the burden laid upon him; but if it seems too heavy he becomes stubborn and self-willed, until he has received a due number of official blows upon the soles of his feet, whereupon he immediately becomes obedient again and bends slavishly before his Turkish master, his superior in energy."

A third important component of the peoples of the Near East, in addition to the nomads and the villagers, are the inhabitants of the towns. Towns were a characteristic feature of Near Eastern lands ever since the dawn of history. Among the most ancient remains of Near Eastern culture are the ruins of towns having the form of *tells*, that is, mounds composed of several successive layers of ruins testifying to several successive epochs of settlement with periods of desolation intervening. These *tells* are mostly very small; in fact, whenever I visited one, I was again and again astonished at their smallness. They rarely exceed two hundred yards in any direction. If you then ask what is the difference between a village and such a small town, the answer must be that the difference lies not in relative size but in mode of construction: towns in ancient days were, as a rule, fortified, while villages were open and unprotected. Mostly, a number of villages were dependent on each town—it is these villages which in the Bible are called "the daughters" of the town—and in times of danger their inhabitants fled behind the relative safety of the walls and gates of their "mother" town.

Towns with dependent villages surrounding them are characteristic to this day of the settled areas of the Near East, even of its deep interior. St. John Philby, when crossing the Arabian desert, found that the oases of the Nejd comprise a central town with scattered hamlets surrounding it and with a few square miles of cultivated land, the population of such an oasis being sometimes as many as 10,000.

As to the distinction between fortified town and open village, this held good down to Turkish days, and it was only in the nineteenth century that outside the walls of the old cities new, open quarters began to grow up, thus giving rise to the characteristic dual appearance of the main towns of the Near East, comprising a small nucleus of an old, walled-in part and a surrounding open, new city.

The most characteristic part of the old cities is no doubt the *suq*, the bazaar. This is a network of extremely narrow streets, mostly covered with vaulted stone roofs or with matting or awning, and having small, open shops on both sides. Each such street is occupied by a different trade, so that there is a *suq* of cloth-merchants, a *suq* of sandal-makers, one of coppersmiths, of spice vendors, butchers, fruit-sellers, jewelers, and so forth. This arrangement, which has, of course, its counterpart even in such a modern city as New York, gives bargaining an additional pleasure, for the buyer can play up the price demanded by one merchant against another. Shopping in the East is in the main bargaining and haggling, so that purchasing even the smallest and cheapest object can easily become an affair protracted over one or even several days. The *suq* is, moreover, the meeting place of everybody; in it or adjoining it are found the cafés where men sit for hours on low backless seats over a small cup of strong Turkish coffee and a gurgling *narghileh* (water pipe) and which are usually crowded and serve as the clearing place for news and rumors. Another meeting place is in and around the gates leading through the walls into the old city. Outside the gate is the traditional

place of the animal market and of the potter displaying his fragile ware, and here meet the *bedouin* and the *fellahin* coming to town to sell or buy. The colorful congregation of all sorts of people in the *suq* and at the gate is the most prominent feature of Near Eastern towns, and, unless one has rubbed shoulders with the throng filling the narrow lanes, one cannot claim to be acquainted with the Orient.

Oriental towns, of course, are much more than a framework for the *suq* and the commercial activities in it. In addition to the merchants and manufacturers, we find living in them members of the few great and rich families who hold in their hands a large share of the economic and political control of the country. The government and its offices are in the towns, and in them live the officials employed in national, regional or local administration. The few academicians and intellectuals included in a traditional oriental society—doctors, lawyers, teachers in higher than elementary schools, writers, many of whom have studied in a foreign school—also have their abode exclusively in the towns, side by side with the more traditional types of intellectuals, such as the preachers and other dignitaries of the mosques, judges of the religious courts, administrators of the *waqf* (charity foundations), leaders of youth and other movements, experts in folk-medicine, soothsayers, diviners, and the like.

Another characteristic of the larger cities all over the Near Eastern area is that in them live strong non-Moslem or non-native minorities with an often higher economic level and having the role of westernizing agents.

A significant feature of the Near Eastern area as a whole is the constant interaction between the nomadic and settled population. This interaction, we know today, has been going on in the Near East since the earliest times. One of its aspects was described in the 14th century by the noted Arab philosopher-historian, Ibn Khaldun, who stated that the population of the sown becomes weakened by its relatively comfortable mode of life so that it cannot repel the attacks of the stronger and more ferocious sons of the desert. The nomads, however, once they have occupied the fertile land, gradually lose their original vigor until they, too, fall victims to the incursion of another group of the desert people.

The same process goes on today, though no more in the form of raids and invasions, but of peaceful, individual or small-group settlement on the part of the *bedouin* on the peripheries of the town. Sir Alec Kirkbride recently described the distinguishable stages of this process in Transjordan, where it is a spontaneous movement. The same process, sponsored by King Ibn Saud, goes on in Arabia proper.

This, however, is only one aspect of the interaction between the desert and the sown. Another, less spectacular, but in the long run perhaps more significant aspect is the economic contact between the *fellah* and the *bedouin*. The mutual opinion of these two is, to be sure, anything but favorable. It is a commonplace which found its way even into Toynbee's books that the nomad regards the agriculturist as a stick-in-the-mud, while the agriculturist regards the nomad as a vagabond. This mutual disdain and distrust notwithstanding, the *fellah* and the *bedouin* are, to a certain extent, in need of each other and frequently meet in marginally situated markets, such as Beersheba in southern Palestine, to buy products of animal husbandry and to sell agricultural or industrial products and *vice versa*. It is an interesting comment on the far-reaching influence of western civilization that, the more advanced the process of westernization in the cultural centers of a country (that is, in its main cities), the greater this economic interaction between the settled and the nomadic population will be.

The same is, of course, true to an even greater extent of the dependence of the

settled rural population on the towns. This, too, grows in direct relation to the intensity of westernization. There is, moreover, a trend to move from the village into the towns, where a man can be more independent socially and better off economically on industrial labor than in the village on the extremely low pay of agricultural labor. The difference between the status of an industrial laborer in the towns and that of an agricultural laborer in the villages can best be characterized by mentioning one significant fact, *viz.*, while in many Near Eastern countries industrial laborers today have their recognized organizations, it still remains illegal for agricultural laborers to form unions.

In addition to the contacts between the various parts of the indigenous population, there is, in the towns all over the Near East, a tendency to assimilate to western civilization, often reinforced, especially in the larger cities, as indicated above, by the presence of European residents.

In conclusion, I wish to repeat and reemphasize that, compared with almost any other area of the globe, the Near East is extremely poor and neglected in anthropological studies. Folklore has received somewhat more attention; of Morocco alone, we possess quite a number of high-caliber studies, dealing in great detail with the ritual, belief, and religion of the inhabitants of this classic country of magic.

Thus, the tasks ahead are great, numerous, important, and urgent. What is needed is first of all a systematic ethnographic survey of the Near East to bring our factual knowledge of it at least up to the level of our information concerning "darkest Africa." Then, particular attention should be paid to the problems special to the Near East, such as the cultural processes taking place there due to contact between various indigenous peoples, or sections of the population, and between these and exponents of western civilization. Here is a wide, practically virgin field, easily accessible and promising valuable results.

Note. The Section of Physics and Chemistry held a meeting on March 2, 1948, at which Doctor John R. Dunning, Columbia University, New York, N. Y., presented a paper entitled, *Future Nuclear Research*, illustrated by lantern slides. No abstract of this has been received.

SPECIAL LECTURE

TIBETAN, TODA, AND TIYA POLYANDRY: A REPORT ON FIELD INVESTIGATIONS

By H. R. H. PRINCE PETER OF GREECE*

The present paper on polyandry in those parts of Asia I have visited has, so far, been given to but a few audiences, for various reasons. It was presented once in London and once in Paris, and I attempted to give it in Cairo during the war, but, interestingly enough, the Egyptian government banned the lecture because it was about polyandry—a subject which they felt might be detrimental to Moslem customs and give ideas to Moslem ladies! Happily, such a development is not likely to take place in this country.

The basic idea behind my investigations was to go out into the field and get an up-to-date knowledge of polyandry by using the psychoanalytical discoveries of the beginning of this century, attempting to work these in with our ethnological and anthropological knowledge of primitive peoples. The material gathered, therefore, will be presented here in this spirit. Unfortunately, after two years and a half in the field, war broke out and I had to interrupt my work in order to go back and fight. This, naturally, was more important at the time, but it did interrupt the work. I am planning, now, to go out again this year with a Danish Expedition, first to southern India and then to Tibet to finish off what was begun earlier.

I am sure many people are wondering why I hit upon polyandry as a special study. I chose it for the following reasons: What interests the psychologists in the West, I should say, is to get as many comparative facts as possible about the psychology of people living in other parts of the world, and especially living in an entirely different family setup, since the results we have obtained clinically in the psychoanalytical field in the West are all based upon our organization, with the father being the head of the family, the inheritance going through the father's line and the child being brought up in that environment. It is of great interest to the psychoanalysts to be able to find societies in which people live under a different family organization, since the structure of the human psyche, as found in the West, is very closely linked with the family organization we have there.

The most obviously different organization seemed to me, to begin with, to be the matriarchal family, as it is known, that is to say, one in which the mother is head of the family and inheritance goes through her family. But, by all known investigations in anthropology, it is obvious that the matrilineal type of family is one in which the mother's brother, that is, the maternal uncle, plays so important a role that the children growing up in such an environment have only a father-substitute in him. Thus, the setup which we have in the West is very similar to the one in the matriarchal family. I thought, therefore, that it would be of greater interest to go out and find something *entirely* different, even more so than the matrilineal family, and polyandry seemed to be the most radically different type or organization because, here, you have a number of fathers, indiscriminate as fathers as we know them, and one mother. The children brought up in this society are surely living in an entirely different setup from ours, and entirely different, too, from the matrilineal and matriarchal tribal societies.

Also, polyandry is little known from an anthropological point of view, and it was worth while to investigate it purely from that angle. The difficulty which I came up against in the beginning was, where to find polyandrous peoples. They are not

* This paper, illustrated by lantern slides and motion pictures, was presented at a Special Lecture of the Academy on March 9, 1948.

well known and have not been extensively studied or recorded. In a book by Professor Westermark, *"The History of Human Marriage,"* which is possibly the best study of this question throughout the world, covering cases of differing family organization, it is only mentioned that polyandry exists in America to some extent, mostly in South America on the coast of Ecuador and also in British and Dutch Guiana; that it exists on the North American continent among some of the American Indian aborigines and among the Eskimos; and that it also occurs in Tibet, in India, mostly in the Himalayas, but also in southwest India, in the Melanesian archipelago, and among some primitive peoples of the Siberian plains. In Africa, it is also known in parts of Uganda and in some tribes of Southeast Africa among the Hottentots.

Thus, I had quite a large choice of locations to study polyandrous peoples. I chose India and Tibet because, from the abovementioned book, I realized that the Tibetians had perhaps the best-preserved and most efficiently organized polyandry of them all, and that in India there seemed to be a number of unrecorded polyandrous peoples which were worth a trip to study on the spot. Then, too, both Tibet and India seemed to be healthful places for an anthropologist to work. In 1937, my wife and I decided to go out there and look for the polyandrous peoples. We visited the Tibetans for eight months in 1938, the Todas in southern India for six months in the summer of 1939, and the Tiyas on the southwest coast of India, in Malabar, for the remaining time, which was roughly about a month, until World War II broke out and we had to interrupt our activities. I shall present my findings in the same order, and end with a synopsis of the whole, giving you my conclusions as to, first, the psychoanalytical results of the investigation and, second, the anthropological results as well.

Tibetan Polyandry. We visited the western part of Tibet because, having reached northwestern India, or, rather, the foothills of the Himalayas on the Indian side, we heard that a certain amount of polyandry existed among the hill people. We went up to where they were reported to exist and found that polyandry had died out, but kept on looking further until we actually ended up on the Tibetan plateau, about 12,000 feet up, and found a very active polyandrous society among both the nomads of Rupchu (a plateau bordering on Kashmir and Tibet) and the inhabitants of Ladak. The latter is a province of what today is the state of Kashmir, entirely inhabited by Tibetans and situated in the upper Indus valley at the point where the Indus leaves Tibet and enters Indian territory. Later, we went towards central Tibet and investigated polyandry in Sikhim, which is a little state bordering on Tibet and sandwiched between the states of Nepal and Bhutan in the east.

The people living in western Tibet live in an isolated position. The country is very barren and, because of the altitude and the difficulties of travel, the people are very inaccessible. These, naturally, are excellent conditions for such a peculiar custom as polyandry to survive and I am sure that, if Tibetan polyandry is so active and well-preserved as it is there, it is due to the physical environment which favors isolation among these people. In the area we visited, 90 per cent of the population was polyandrous and I understand that nearly all the inhabitants of the vast Tibetan country, of which there are something like three million, are polyandrous, though, of course, it would take actual first-hand investigation to be absolutely sure that this is the case.

The polyandry practised among the Tibetans is of both the fraternal and the nonfraternal type, that is, when a young lady marries a young man she either marries all his brothers regardless of age (she can even be the wife of children born after her marriage), or she can take as many husbands as she desires, without their being related as brothers, at her discretion. I

shall try to show why in some cases polyandry is fraternal, and in others non-fraternal.

The province of Ladak, which I visited, is inhabited by Tibetans speaking an ancient form of the language. Tibet, of course, is run by the Lamaist church and the head of the country is the Dalai Lama. The former kings of Tibet have taken refuge in Ladak since the 8th century A. D. and live in the castle of Leh. The town is very characteristic of Tibetan towns. Flat-roofed houses are very well built on the side of high mountains. The altitude is 12,000 feet, the entire area is snowed in during the winter, and the people live mostly in their houses and do not go out.

These Tibetan houses are not very different from our own western type of houses, except in one respect. The kitchen here has no chimney, so it can be imagined how much smoke fills the room when they cook. The Tibetans do not seem to mind; though we personally found it very difficult to stand upright in their kitchens when they were cooking and so spent most of our time there on all fours, to avoid the smoke and keep our eyes from watering. The people suffer from eye trouble because of this practice and yet they seem to stick to it in a very curious manner.

The characteristic dress of the Ladak women is of red cloth such as the men wear. They have a sheepskin toga which they throw over their shoulders and a very characteristic head-dress, made of a piece of red felt with two enormous ears of black wool. The red felt band is studded with turquoises at the back, family heirlooms, handed down from mother to daughter. Such a headdress is known as a *perak*.

The men are tough-looking. They very often have their right shoulders bare; though sometimes they have a Chinese shirt thrown over them. When they are working, they usually have the right shoulder uncovered, however cold the weather may be. Looking at Tibetan children, one could imagine at first sight that they have two heads, but the explanation is that they generally carry a younger brother or sister on their back because the mother is at work in the house and cannot look after them.

It is a fact that all Tibetans are literate, men and women alike. Whatever class they belong to, between the ages of 8 and 12 they have to go to the monastery to learn the Buddhist religion, learning to read and write at the same time. This gives these people a very high standard of culture.

The first thing to grasp in Tibetan polyandry is that the Tibetans are very keen to keep the property together. The country is poor, and they feel that if the property is divided among several heirs there will not be enough to go around. They not only wish to keep the property intact but also to maintain the family name to this property. Thus, when a certain number of brothers, let us say, three, inherit the property and the house, they do not divide it among themselves but, marrying one woman as they do, they share not only the property but also the woman as a common wife, as well as the children, which belong to all of them together. It is a kind of family communism, and certainly prevents division of the property.

Thus, the usual type of marriage is that a number of brothers marry one woman and keep the property. This is called a *bagma* marriage in Tibetan. However, if there are only girls in the family, what usually happens is that the younger girls go off and marry into other families, individually becoming the common wives of a number of brothers. They thus perform the regular *bagma* marriage. The eldest daughter, however, since she has no brothers, inherits both the name and property from her fathers and and is allowed to marry as many husbands as she wishes. These husbands and the children, too, take her name, so that, in this way, the children which issue from the marriage take on the mother's name and inherit the property undivided, and again make regular *bagma*

marriages. The woman's marriage, in this case, is known as a *magpa* marriage. It differs from the *bagma* marriage in that the woman is head of the family. The husbands are married to her and she can do exactly as she wants with them.

The most important point to grasp in polyandry is that the house is the axis around which the system functions. In taking down genealogical notes I have, therefore, always given the family the name of the house.

A specialized case I came across was that of an only son of the house called Tsungarpa who married one woman, the heiress to the Bata house (see FIGURE 1). All her brothers were dead, so that she and her husband actually owned two houses and they had what, on the surface, looked like an ordinary monogamous marriage. However, the two properties were not amalgamated. The woman was to carry on the name of Bata and the man that of the Tsungarpa house. Consequently, of the three boys which issued from this marriage, the first two inherited the Tsungarpa house, while the youngest inherited his mother's house and was entrusted with carrying on the name of that family.

One of the sons of these three brothers, Murup, inherited the Bata house from his uncle, but remained childless after twenty years of marriage. In such a case, oddly

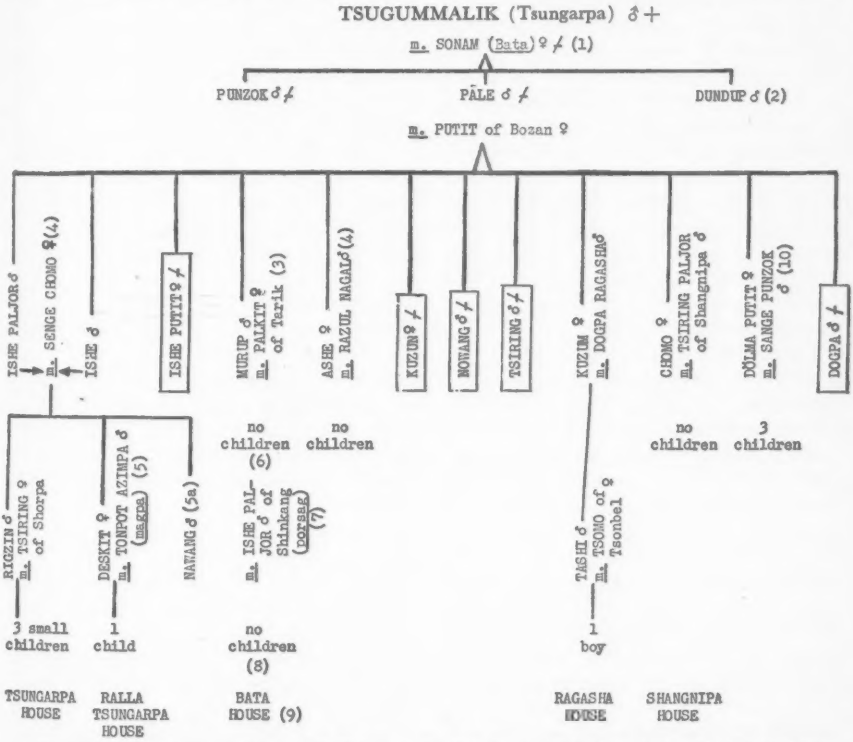

FIGURE 1. The Tsungarpa house. (1) Heiress to the Bata house—all brothers dead. (2) Put in charge of the lone Bata house. (3) Given the Bata house. (4) A Mohammedan—the woman takes the man's religion. (5) Land only held in tenancy. (5a) Becomes a Lama at Himis monastery. (6) After 20 years. (7) Murup is single-handed. (8) After 4 years. (9) Could adopt a child to carry on. (10) No land, as formerly Mohammedan; messenger at Himis monastery. † Deceased.

enough, the Tibetans seem to think that it is the husband's fault and they usually take in another man, in the hope that there will be children. Such a man is known as a *porsag,* that is, a man brought in for the purpose of fathering a child. However, when I asked this woman why she had remarried, if it was because she had no children, or because her husband was too old, she said, "No, those are only the official reasons." After I gained her confidence, she told me that she had married the second husband because she needed a servant in the house, and she found it cheaper to have another husband than to have a servant she would have to pay!

If a Tibetan woman marries a Mohammedan, she has to leave the polyandrous practice and becomes a member of the usual Mohammedan family system. The woman always takes the husband's religion, so that a Moslem girl who marries into a Buddhist family becomes polyandrous.

Now it must not be imagined that polygyny (where a man has a number of wives) does not exist in Tibet. One occasionally finds a case as when a young man goes on a long voyage and meets a girl of his choice and his brothers agree to bring her into the house. Thus, in Rupchu, I have seen three brothers sharing two wives, so that anything seems to be possible among the Tibetans and, on the whole, the system seems to work very well.

The children in Tibet are betrothed when they are 10 or 12 years old, usually by the parents. But this is not always the case. Very often the eldest boy chooses a wife himself, and his brothers and the other members of his family have to accept this woman as the common wife; they have no choice in the matter. But there is yet another custom in the Tibetan family which to us Westerners appears extraordinary indeed. As soon as the children are married, the parents are obliged to leave the house and the children take over. The father and mother must go to live in a smaller house, usually on the same property, which is built especially for that purpose. This custom is known as *kangoo, kangchen choches* which in Tibetan means "small house, big house division." The children then become responsible for the agricultural and commercial activity, while the parents must live on an allowance or on a small part of the property which is put aside for them (called *maskal* if it is for the mother, and *paskal* if it is for the fathers). This custom, though not rigidly enforced, seems very strange to us, since in our society the parents remain in charge of the family property until they die and the children have to go and earn a living for the family which they found.

It cannot be said that, in a Tibetan polyandrous family, one of the brothers is *eo ipso* more important that the others. For instance, it is not necessarily the eldest brother who is the head of the family, but usually the one with the most personality and sometimes even the mother, if she is in a position to run the family. The fathers are often somewhat afraid of their sons, because as soon as the sons become married, the parents have to leave the house. Thus, they try to ingratiate their children so that they will be left a sufficient amount of property on which to live when the children marry.

There is an initiation ceremony among the Tibetans, as with many other peoples in the world. It consists in the boys and girls having their hair cut at an early age, usually between their second and third year, by the mother together with one of the fathers, usually the most influential one.

There seems to be no fixed rule as to how a polyandrous family works out relations between husbands and wife. Most people seem to imagine that it is left to the wife to regulate with whom she shall have relations, but this is not always the case. If it is left to her, she naturally has to use tact so that the boys are all satisfied, but, in other cases, the decision is up to the brothers themselves, who remain at

home, in turn, while the others go off on commercial journeys. This idea of one brother staying in the house and looking after the common wife is what many anthropologists believe to be the explanation as to why these people practice polyandry; that is, so that they can be sure the children issuing from the marriage will be at least from the same family, even if they are not those of one particular man. Thus, during the war, I saw a Sikh officer (an Englishman) who received a request from one of his soldiers to go home because, he said, his wife had had a child. The officer said, "But you have been away for two years, so how can your wife have had a child? Is that any reason to go back?" And the Sikh answered, "Yes, but my brother was at home," and then retracted his words, because the Sikhs, at least, do not like admitting they are polyandrous, though it certainly exists in the northern part of the Punjab, among them as well as among the Hindu *jats*.

In Leh, I was struck by the fact that, in most families, there seems to be no organization at all. Complete promiscuity apparently exists between the brothers and the common wife, especially during the winter months when the place is very often snowed in completely and the whole family lives in one room because they have not enough fuel to heat the whole house. This I found out both from questioning the people and from hearing details from Europeans who have gone into the question before.

Oddly enough, however, in all anthropological books about polyandry, one hears that the brothers, in turn, go in to the wife and signal their presence in the nuptial room to the other brothers by leaving some mark at the door. They either put their sword against the door or their stick, or leave their shoes or hat outside, or hang their beads on a hook at the door as a signal that they are in with the common wife and the other brothers may have no access to the room. When I examined this first-hand, however, and also in the case of other polyandrous peoples like the Todas and Tiyas, I found that they say this is not practised any longer, but that it used to be a custom two or three generations back. I have never found a case of its actually being practised today and, for this reason, I have strong psychoanalytical suspicions that it has never been practised, but that this story has been put out by polyandrous people as an indication of, what I should call popularly, "wishful thinking." Each of the brothers would like, in some way, to have the common wife all to himself and would like to manifest this virility on his part by hanging up some emblem at the door. The sword, the stick, the shoes, the hat, and even the beads are all, psychoanalytically, symbols of virility, and it seems as if the men would *like* to have this custom which, possibly, has never existed, and each of them gains a certain satisfaction in thus imagining a virility which he feels he does not have.

The morality of the polyandrous people is very high. I mean by this that, as polyandry is an institutionalized social system, they stick to it very strictly. If you ask missionaries who have been among polyandrous people, they will, of course, tell you that polyandry is a very immoral practice. But if you speak to the people themselves, they, on the contrary, consider it highly immoral not to be polyandrous. If we take as the definition of morality, conformity to the social standards of the setting in which one lives, then one can say that polyandrous people, at least in this area which I studied, are very moral. The old people complain that today the young ones are getting highly immoral and lax in not carrying out the tradition of polyandry. Certainly, on the borders of India, where the people come in contact with the monogamous families of India, or with Europeans, polyandry is dying out to some extent.

I remember speaking to an old Tibetan called Tocktock in Leh, who told me that, in town, Indian and Turki traders (the latter from Chinese Turkestan), and Euro-

pean travelers were introducing the bad habit of monogamous marriage, and that the young men were getting more and more immoral. I suppose he was quite right, and as I was interested to hear his point of view we had quite a conversation about it. He next asked me how, in Europe, we managed to remain wealthy without being polyandrous. He said to me, "Here in Tibet we haven't enough to go around and as we don't want to divide the property up we have to be polyandrous so that we inherit the property without its being divided. But how do you Europeans do it? How do you remain wealthy by being monogamous and dividing up your property?"

I must say I had not thought of this before. It only occurred to me when I was talking to this man. So I said, "Yes, now that I think of it, it is probably true that in Europe we do things in a different way. When we marry, each man goes off with his wife and they try to fend for themselves, build up their own family and get their own source of revenue. That is the way we do it. There is enough wealth to go around to found other families." "Yes," the old man said, "That is true. I have noticed among the Tibetans who have become Moslems that this is also the case. They cease being polyandrous, and because of that they then divide up the property. There is not enough to go around. The eldest brother usually gets it and the youngest brothers have to go off with their wives elsewhere to find some work. I have also noticed here that nearly all the Mohammedan families seem to go to Burma and work in the ruby mines there. That is obviously for the same reason you are telling me now about Europeans." Then he was silent for a moment and looked at me in a pensive fashion until suddenly he said, "Now I understand why you Europeans come here. That is why you have got colonies. If you were polyandrous you wouldn't need to!"

One question I am very often asked is, does jealousy exist within the various houses? I have the impression that it does exist but that it is very highly repressed by this institution of polyandry. Tibetans, when asked if they are jealous among themselves, will always answer that they cannot afford to be jealous because of the economic sanction against it. If they started quarreling among brothers, they would have to divide up the property. They would then be too poor to carry on, and this threat makes it impossible for them to show their jealousy.

As it is, there seem to be some outlets for it. I have noticed a number of what one might term "unjustified" *magpa* marriages, cases of young men who were married jointly with their brothers to one woman and yet each went off and married an heiress. Such a man could have remained married to the common wife, but was lucky enough to find an heiress he could marry and he certainly did so at once, because it gave him some justifiable motive for having a wife all to himself. There are very many such cases of *magpa* marriages which are not justifiable, in the case of the males, except for the desire to break away from a polyandrous family.

A certain amount of neurotic cases among brothers can also be noticed, which shows that jealousy certainly exists unconsciously in their psyche. I saw a young man in Keylong, in Lahaul, where we were staying for a month (or, rather, I heard about it because it had just happened when we arrived there), who had committed suicide because he felt that the common wife was not giving him enough chance of access to her. He was in love with her and his other brothers were obstacles, so he committed suicide. In Leh, I actually saw a young man who for many years, as long as his brothers were alive, had suffered from a paralysis of one of his legs. His brothers died off one after another until he was left alone with the common wife, and queerly enough, that very day he lost the lameness in his leg, so that it looked as if it had been a hysterical manifestation due to repressed aggression

within him, certainly caused by jealousy of his other brothers for their relations with the common wife.

There are certain instances of extra-marital relations between people in this polyandrous community, but they are highly condemned and heavy sanctions are applied. In a *bagma* marriage, if the woman commits adultery, she is turned out of the house if she is childless, and the brothers choose another wife. If she is with child, she is fined and has to pay out of her personal property. As for the man, the co-respondent, he is beaten and/or has to pay compensation to the legal husbands. In a *magpa* marriage, where the woman is heir to the property, has the care of it and can marry as many men as she desires, infidelity of the wife is the only case in which the husbands can get a divorce. Otherwise, she can divorce them, but not *vice versa.* If the man is the adulterer in such a marriage, nothing is done except in the family where he has committed the adultery. In the case of unmarried people, the woman is usually turned out of the house if she has premarital relations and should attempt to marry the man with whom she has had these relations. If the trespasser is a man, he is treated exactly like an adulterer in the usual *bagma* marriage.

Illegitimate children are usually hushed up. They are often adopted into some family or are sent to the monasteries as novices, so that nobody knows exactly what their origins are. As far as I could find out, there seems to be no prostitution in Tibet, and husbands suffering from the polyandrous organization do not have that outlet. Something, however, certainly is known about prostitution, for Tibetans, who never smoke, tell you that they do not do so because tobacco was a plant grown with the menstrual flow of a prostitute.

As far as I could find out, homo-sexuality is condemned, even in the monasteries, and certainly despised if practised, and I could not find any proof of it. But local Europeans who know the Tibetans very well, such as the Moravian missionaries who live among them in the western part of Tibet, explain that, on the whole, they are not very passionate people, but rather cold. Certainly, their polyandrous institution has much to do with the repression of their natural feelings.

Oddly enough, the Buddhist religion condemns not only polygyny and divorce, but also polyandry, and yet all Tibetans who are Buddhists practise it. Thus, it must be a pre-Buddhist custom. The Moslems, however (that is, those Tibetans who are converted to Mohammedanism) cease being polyandrous immediately and take to the Islamic polygynous system.

There exists a very rare case of polyandry in Tibet which it has not yet been my privilege to come across, but of which I heard repeatedly in western Tibet. It is practised in a society which I understand exists in central Tibet around Lhasa and Gyantse. In these towns, the fathers and sons share one wife. One of the objects of my returning now, at the end of the year, to Tibet, is to meet a woman who is thus married to both father and sons. Such a woman is known in Tibetan as a *tchama-doong,* which means "beam-mother-beam" a name derived from an analogy in the build of their houses. These have flat roofs, built over a number of beams, large transversal beams and others, which are smaller, going across them, and very small bits of wood which link the two together. When they call such a woman a *tchama-doong,* they mean she is comparable to a small beam, that she links the big beam with the small bits.

It must not be imagined for a minute, of course, that this woman is the mother of the sons. But let us assume the case of a family in which there are a number of brothers, who have married one woman and have a number of offspring. If this mother dies, the fathers can either remarry and, in this case, the sons are entitled to share the stepmother with their fathers, or, if the sons are married when the mother dies, the fathers, instead of remarrying, are

entitled to share the daughter-in-law with their sons. That, as I say, is practiced only in central Tibet but is well known in the entire country. The children issued from such a marriage legally have as fathers those to whom the wife was officially married at the moment of the birth. That is, if widowers share their daughter-in-law with their sons, the children of that woman are the children of the sons, so that your legal grandchildren can be your own physiological children and, *vice versa,* if it is the fathers who are legally married to the woman, your legal brother can well be your own physiological son!

I understand that Tibetans from other parts of the country rather despise this form of marriage. I have caught my caravaneers openly insulting central Tibetans as being *tchamadoong*-practicing. Also, when they are playing dice, I noticed that sometimes they invoke the *tchamadoong* to produce luck for them, so that she is a double kind of figure to whom they cannot be entirely indifferent: they despise her and yet, at the same time, she can bring them luck.

I do not know how far the existence of the *tchamadoong* has been reported in anthropological circles heretofore. Personally, I have never heard of this system before, except on the spot, and I am very keen to go back and study it. The case to which we came closest was the governor in the western province of Tibet, named Ngari Korsum. He was living in the capital, Gartok, when we were there. He was a central Tibetan sent by the central government to govern that province, and with him were his two sons and their one wife. She was a *tchamadoong,* the wife of the boys, the father sharing her with his sons. I was shown a photograph of her, taken by a Tibetan who had a camera from India, and that is the closest I have been, so far, to such a woman. I understand that in southern India there is a similar practice, in which a father is entitled to enjoy his daughter-in-law as long as his son is a minor, but this practice is not exactly the same for it is not an institutionalized form of marriage, the way the *tchamadoong* is in Tibet. A monk I met at Spitook, a monastery close to Leh in Ladak, told me that he knew five families with *tchamadoongs* in Gyantse. I have noted their names and hope to be able to study them on the spot.

Toda Polyandry. I shall now try to show how polyandry, as practiced by the Todas, differs radically from the Tibetan system. This is a worth-while consideration, for it shows how polyandry, though it is basically the same organization, can appear in different forms throughout the world.

The Todas are probably the best-known primitive people in the world. Anthropologists mention them repeatedly. They live in the southern Indian hills, called Nilghiris, west of Madras. There are very few of them left, only about 600, and they were very well described by Doctor Rivers at the beginning of this century, though much could still be learned about them, as Rivers admits himself. He made many discoveries, but also made several mistakes. In his book, the chapter on religion tells the amusing story of some investigators who had been there before, who tried to note down the names of the various gods the Todas have in their shrines. One god has a very long name, which, to this author, seemed to be correct, but, as Rivers pointed out in his book, the words that appeared as the "name" really mean, in Toda, "Give me another rupee and I will tell you what this god is called." It is easy to understand what happened. I think that similar progress could be made in the investigation of Toda polyandry, but that Rivers did not go into it completely and sufficiently.

Unfortunately, as I have said, the Todas are a dying-out people, there being only 600 left, of which only about 50 per cent are polyandrous, *i.e.,* a much smaller proportion than among the Tibetans. The Todas are divided into two main clans, a superior leading class called the Thartars,

and an inferior clan which serves the Thartars, known as Teivil. They have no landed property like the Tibetans, but are herdsmen and have large herds of buffalo, some of which are sacred. In this case, therefore, we do not find the polyandry grouped around landed property which is not supposed to be divided. The Todas only practise fraternal polyandry, and when I asked them if they practised non-fraternal polyandry, as in the case of the *magpa* marriage among the Tibetans, they were very shocked. They thought it was a very immoral idea that two men, not being brothers, could have one wife in common.

The country in which these Todas live is not barren like Tibet. On the contrary, they live in a very wooded area. Part of the present Todas actually live on a golf course, because British troops have quarters in this area and the officers have set up a sporting club which includes part of the Toda territory. The houses are very small, built only for protection, and radically different from any native construction which their neighbors have. I do not know where they got this architectural style, and nobody has been able to trace its origin. There is a rather tiny door through which one has to bend to enter. The house is all thatched, very well built, and quite snug inside. The front is made of boards, and there is a wall around for protection.

Men and women alike are dressed in long, flowing, white robes, with red and black stripes on them. They are of an obviously Indian type, rather good-looking. Some of them have progressive ideas to the extent of wearing spectacles, because they are either far- or short-sighted. They are quite good physical specimens of humanity, the color of their skin being dark brown and their hair jet black. The men are very hairy. Some of them wear turbans, but usually they go about bare-headed, showing a rich growth of black hair which they all have, young and old. I wondered if they had a secret formula for hair-dressing but they do not seem to have any except buffalo butter, which they rub into it. They are very fond of sporting games, and the country is green and rolling with many hills and is very nice to play about in.

A Toda genealogy, analyzed in detail, will best enable us to compare their system to the Tibetan. As I said at the start, the property here is not the axis around which polyandry turns.

Three brothers married, polyandrously, a young lady, Potöz (see FIGURE 2). She was married to one of her cousins when she was two years old, as is the practice. When she came of age, however, she married these three brothers. She had no children and died quite early, so that the three brothers were left without any children and without a wife. Then, the following thing occurred. The eldest brother Eroï, married a young woman, known as Sotaboof, and went off on his own; *i.e.*, he was not willing that his two brothers should share this woman with him. He became a government agent, and because he had founded a family of his own, he was entitled to take his part of the buffalo belonging in common to all three brothers. He took one-third of the buffalo away, and two extra, although I cannot remember why; but the important thing is that he was entitled to a share of the common property.

The two others tried to marry a woman called Mab. The second brother, Kiel, asked Mab's father, but the father started haggling with him over the bride-price. (They have to pay a price for a girl, a custom which does not exist among the Tibetans.) The girl's father wanted nine buffaloes, which the young man would not give and left in a huff. Then the third brother, Konoch, married Mab, and soon after she became pregnant. In the meantime, her father died and the second brother, hearing of this from Konoch, returned to the house and asked if she would accept him as her second husband, which she did, even though she was pregnant from the third brother. The

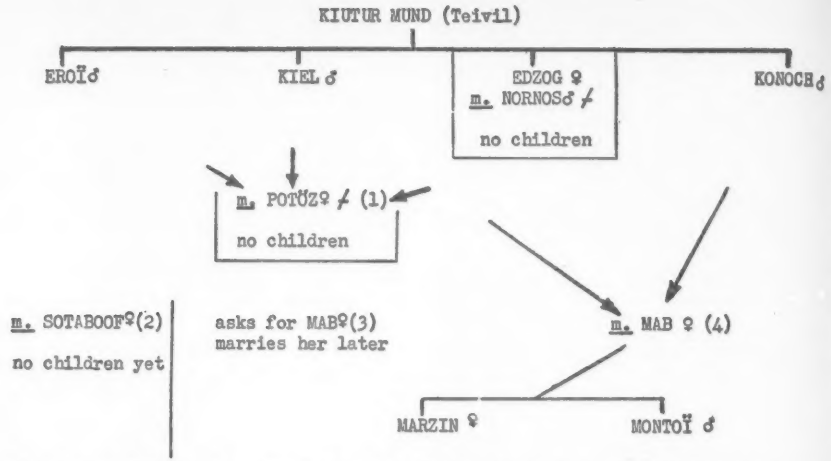

FIGURE 2. A Toda genealogy. (1) First married to Kazan when two years old. (2) Becomes a government peon; takes one-third of the buffalo plus two away. (3) Quarrels with her father over bride price; leaves with one-third of the buffalo but comes back and marries Mab after his brother, Konoch, has already married her. (4) Konoch originally is left with one-third of the buffalo (four). Mab becomes pregnant before Kiel joins in the marriage. † Deceased. Arrows denote polyandrous marriages.

second brother had also left, when he ran away in a huff, with one-third plus two of the buffalo, which he now merged again with the third brother's, so that two-thirds of the original buffalo (minus two which went with the first brother) again became the common property of these two brothers. They thus had one wife and later shared the two children born of the marriage, a girl, Marzin, born shortly after the polyandrous marriage, and a boy, Montoï, of whom the mother told me that she did not know which of the two was his father, and that she had no preference, because she was a good polyandrous wife to both.

The Todas do not practice polygyny as the Tibetans do. They were shocked that I should even mention it. Brothers who have left the house (like the first one in the above example) are not allowed to return with some other wife and share her with their brothers. This is never practised and, even when a brother leaves, he is only given one chance to come back alone to the family fold. Should he do it a second time, he is turned out of the house and the brother or brothers living with the wife are exclusively entitled to her.

Instead of the Tibetan practice, in which the children are betrothed by the parents early, the Todas have a custom of marrying first cousins very early, as child marriages are common nearly all over southern India. In such a marriage, the betrothal would likely take place at least in the first or second year, and always between cousins, the boys marrying paternal girl cousins and the girls marrying maternal boy cousins. Later, these marriages are dissolved by divorce and the children are entitled to remarry by inclination, but compensation is always paid to the "legal" husband. This is worked out in a traditional manner, so that it is certainly a survival of some older form of marriage.

Another difference with Tibetan polyandry, in the case of the Todas, is that one man is usually declared the father of the children, though this is not always so. In the aforementioned case of Mab, the woman said she had no preference as to who was the father of her children. The woman is regarded as part of the goods

and chattel of the men. She is looked down upon, considered as part of the property, as part of the household, and must pay obeisance to her husbands. She does this by bending down and putting her head under the feet of the husbands, which is the typical Toda salute of respect. There is an initiation ceremony very similar to the Tibetan one, in which the boys' and girls' hair is cut early and even one of the ears is pierced. However, here it differs from the Tibetan custom, in that it is the maternal uncle who does this, which is rather curious and may show some influence of a matrilineal, matriarchal nature.

Particularly extraordinary among the Todas is the fact that no girl of the Thartar clan (the superior section of the Todas) is allowed to be married as a virgin. She has to be deflorated first by a member of the Teivil clan. This seemed to me to be so extraordinary that I decided to look into it a bit more closely. Teivil girls can marry as virgins, but the Thartar girls must be deflorated first by a Teivil before they can marry a Thartar. Naturally, that kind of thing is difficult to find out about, because the people are too shy to speak about it. When I finally got hold of an old Toda and asked him what the reason was, it took me at least a month to find out. I gave him a lot of presents, among other things a bag of rice and a calf buffalo, and still he would not speak. Finally, I found out that it was not that he was unwilling to do it despite the presents I had given him; on the contrary, he would have very much liked to tell me about it, but seemed to be scared to speak about it in the Toda area. He was afraid of the spirits and the Toda gods if he revealed so intimate a secret. Consequently, I decided to take him miles away, out of the Toda area, where his gods and spirits could not get hold of him. We drove at least 100 miles away from the Nilghiris before we stopped by the side of the road and I again asked him, "Why do you practice this custom?" His answer was very interesting. He said that, if they did not do this, the maternal uncle of the girl would die. This seemed very surprising, so I asked why. He said, "I do not know. It is like that. If she were allowed to marry as a virgin, her maternal uncle would die." When asked what would happen if the girl actually did marry as a virgin, he said, "Sometimes it happens, and there is just one chance again for the maternal uncle to save himself. That is, he should take the young girl and shave all her hair off. It is the only chance he has of saving his life."

I thought, from a psychoanalytical point of view, this was most interesting because it seems to me as if there were a feeling of guilt in the defloration of such a young lady; that the Oedipus complex comes out here although it has been transferred to the maternal uncle. He is the one who is threatened by consummation of the act (as a father would be in a son-father sexual conflict), and he can only save himself by castrating the girl (displacement of the suitor?) by cutting off her hair. Those are hypothetical psychoanalytical interpretations, I know, but they seem to me strong indications that these people have probably much the same complexes that we have in the West.

Relationships between the husbands and the wife among the Todas are different from those among the Tibetans. They are not promiscuous in any way, and in their marital relations the brothers go strictly in turn. They, too, will tell you that, in past times, their grandfathers (or ancestors still further removed) used to leave their stick at the door, or their shoes, or something, always to show they were there. This is not practiced "any more"; the brothers know by intuition that one of them is with the common wife, or he tells the others openly that he is going to do it.

As far as morality is concerned, polyandry is not enforced in the same way as among the Tibetans. It is somewhat lax and usually applied only to the woman. The men perpetually seem to be stealing

one another's wives, and it happens that they can even retain such a woman they have stolen from other families, if they pay compensation to the husbands. This goes on continually and one sees some women who have been to three or four families in turn. The Todas do not seem to be any more jealous than the Tibetans, but perhaps this very laxity gives an outlet for jealousy, since they can steal one another's women, so that this does not appear to be a good instance for the study of jealousy among a polyandrous people.

There are numerous extra-marital relations, which are tolerated as long as they take place among Todas. At the funeral of a Toda woman, it is curious to note that there is one individual who officiates in addition to the husbands, and usually he is supposed to be the official lover of the woman. This looks peculiar, since they have it only in a ritual, and it may indicate that they once practised non-fraternal polyandry and that this official lover who officiates together with the husbands is perhaps only a survival of a non-fraternal mate.

Pre-nuptial relations are forbidden among both men and women, and there are never any illegitimate children among the Todas, as they are always born within one family (since "marriage" takes place in infancy) and considered legitimate. The men alone are allowed to divorce, but women may never do so. The usual ground for divorce is that they have stolen one another's wives. The only case in which a woman is divorced with ignominy is if she has had relations with a non-Toda. In that case, she is driven from her home, her hair cut, and usually tied to a buffalo with coconuts attached to its neck, after being beaten by the community.

The impression I got was that Toda polyandry was loose and decadent, and that, today, we see only the remnants of a former, more efficient type of polyandrous organization.

Tiya Polyandry. The Tiyas, living in Malabar, exhibit one especially interesting phenomenon: they are a polyandrous people who are patrilocal (that is, the woman marries and goes to live with her husbands), but also matrilineal (that is, the property that they have—and they do not have much, because they are common laborers—is inherited from the mother's brothers). Unfortunately, I did not have much time to investigate these people because the war broke out when I had only been at work among them for three weeks. Thus, the only thing I could note was that they are polyandrous, patrilocal, and matrilineal at the same time. I should like to return and see how this works out.

General Conclusions. I am afraid that some of these results may seem superficial. I was unable to stay as long as I should have liked among all these peoples. I did not know any of their languages well, and to really do good field work, one would have to live among them and not put questions to them as I did. However, I hope to return and to do a more thorough study.

As far as the psychoanalytical results are concerned, I think that they are highly illuminating, though not sufficiently ample to be conclusive. There are strong indications that, broadly speaking, psychic mechanisms, libidinal development and mental structure may be identical to those in the West. There are, thus, numerous instances of trends pointing to Oedipus and castration complexes. What I, however, really investigated insufficiently was where we should place the relative borderline between what is specifically culturally determined in psychology (such as traits due to family environment) and what is generally humanly so (such as sociobiological traits).

As far as the ethnological results are concerned, these can be examined from two different angles. Functionally, polyandry fulfils the same purpose as all other marriages: it is a social institution for the satisfaction of the individual sexual in-

stinct and for the orderly social procreation of offspring. Formally, it is more difficult to say why this institution has taken on this curious appearance. As far as I know, authors so far have been rather at a loss to furnish a satisfactory explanation. Many, of course, have been given, with a great amount of variety in their choice.

For instance, we are given historical explanations. In India they say people have been polyandrous for many centuries; that there are indications, such as archaeological (about the Heftalite Huns, 6th c. A.D.) and literary (the Indian epic poem, the Mahabarata), that the people in this area, both Aryan and non-Aryan, were polyandrous in antiquity. Economic reasons for this have been given; *i.e.*, that the country is poor, that nomadism among Todas or Tibetans, in earlier times, perhaps led to a polyandrous society in order to limit the number of children. Then, demographical explanations have been given, that there is an excess of males over females in this society, and that they have to be polyandrous for that reason. For instance, the Todas practise female infanticide and this is given as a reason for their polyandry. Their men drink a lot of milk, and some people say that the fact that they have more proteins in their diet in this fashion produces more male offspring than female. I do not pretend to know how far this biological explanation is true. Sociological reasons have also been given, namely, that the men travel and have to leave one brother at home with the wife (a reason which I hinted at earlier). In east and south India, the people known as the Nayars, who once could also be called polyandrous, had a very definite military organization (somewhat like that of the Sikhs in the north), and that has been given as a reason why a people is polyandrous: one brother can always remain at home with the wife while the other is away serving with the colors.

It seems to me that these explanations are not sufficient. As far as the historical reasons are concerned, the Mahabarata epic is the only case of its kind in the whole of India. The Todas, when you ask why they are polyandrous, always say "Because we are the same people as those of the Mahabarata", but I am convinced that they have got this explanation from the anthropologists and not the other way around! As far as the economic reasons are concerned, these also seem to me insufficient, because there are people living in the same area, in the same physical environment, who are not polyandrous. Even the Tibetans, when they become Moslems, though their environment does not change, suddenly cease being polyandrous and live in the Islamic fashion. The rich Tibetans in central Tibet are also polyandrous, and obviously not for economic reasons.

As regards the demographic reasons, the following statistics will show that there is not always an excess of males over females. In the Leh *tehsil* in Ladak, where I was, there are 14,760 men to 14,650 women, which is approximately equal. The excess of single women among the Tibetans (there are some left over, naturally, considering the number of brothers who have one wife) usually go into a monastery and become nuns. That is the way they solve their problem. The Todas, on the other hand, practise female infanticide, so that there are less women than men. However, back in Tibet, in the same town of Leh, one finds that the Hindus who live there number 36 men and 13 women, and yet they are monogamous. In southern India, there is a Moslem community known as the Moplahs, in which there are five men to one woman, and they are polygynous rather than polyandrous. Even in Europe, the Bulgars have 35,000 more men than women and yet, though they may have many faults, they certainly are not polyandrous.

As far as the Todas are concerned, out of the 600-odd that exist, there are 340 men and 237 women, so that it really looks as if the reason given might be true in

this case. But as Rivers has very well pointed out—"which comes first?" It is the old problem of the egg and the hen. Do they kill off their little girls because they wish to remain polyandrous, or are they polyandrous because they have more men than women owing to the practice of female infanticide? If the latter, the fact that they can steal one another's women would be another solution to the problem, so that again the demographic reasons seem to be insufficient.

Being unsatisfied with these explanations of polyandry given by various authors, I decided to find out from the people themselves why they are polyandrous. I do not think this has been done before. Most people find out about polyandry and then they try to think up some explanation for it, but no one has gone and asked the people themselves. Of course, when I checked the scientific explanations against their ideas, I got various answers.

There was no other answer from the Todas about the Mahabarata than that which I have already discussed. As far as the economic reasons are concerned, the Tibetans did say yes, they lived in poor surroundings and that is why they are polyandrous. Demographic reasons (that there are more men than women) were never mentioned, while sociological reasons such as frequent traveling (one brother having to remain at home with the wife) were mentioned often. But I was struck by the fact that, of the 100 answers I got, at least 95 were quite different from all the scientific explanations.

The usual answer I got was, "We are polyandrous so that our wives will not quarrel." The Todas even said that they are polyandrous because they do not want the *brothers* to quarrel with one another. And I must say that I found this explanation by the people themselves much more convincing, from a psychological point of view, than the academic explanations of certain authors. Basing my own view on the answers of the people themselves, I would give the following interpretation of the polyandrous systems found: It seems to me that polyandry is "not necessarily a primitive institutional form of marriage, but that it is due to the psychological reaction of individuals living in communities subject to environmentally poor and insecure economic conditions, persisting, in the case of the Tibetans, through isolation from other communities, or, in the case of the Todas, as a type of defense mechanism against invasion by other cultures." I have not included the Tiyas in this definition because I do not know them sufficiently and would like to go more thoroughly into their polyandry before giving an interpretation of it.

Now, if I take this definition, instance by instance, I shall be able to interpret exactly what I mean by it. When I first say that polyandry is "not necessarily a primitive institutional form of marriage," I mean that, for instance, the Tibetans are all literate and educated people, with whom you can speak quite freely, who have a very pronounced sense of reality and do not in any way seem like a primitive people. It thus looks as if polyandry were a system entirely outside of the usual evolutionary stages of marriage, in which anthropology puts the matriarchal before the patriarchal system.

Next, I say that polyandry is "due to the psychological reaction of individuals living in communities subject to environmentally poor and economically insecure conditions," by which I mean, living in a physical environment which leads to a miserable economy. This economy makes them very interdependent, within each family, upon the help of each other, and this interdependence, in turn, which is stressed very highly in these families because of the necessity of sticking together under the difficult physical conditions, calls for less aggression among the members of the family itself and among groups of them. It seems to me that this stress on the condemnation of aggression is such that even something approaching incest

appears as less dangerous than aggression among brothers. In fact, the balance between aggression and love for one another is upset in favor of love, and this is so effective that latent, repressed incestuous strivings are forced out by an excuse, I should say, of loving one another and are less condemned than aggression between brothers.

I am convinced that it is this feeling that finds its expression in the Tibetans and Todas saying, "We are polyandrous because we do not want to quarrel among ourselves." (The Tibetans say that they do not want the women to quarrel, by which indirectly they mean that, if the women are quarreling, the men will have to take sides and would quarrel. The Todas are more definite about it and say outright that they are polyandrous because they do not want the brothers to quarrel.) These people actually feel that a practice of aggression, of rivalry between brothers is more dangerous than the custom of sharing one woman, which has led to the establishment of a community in which it has become compulsory to live in this fashion.

It is very characteristic of polyandrous people that they insist on being polyandrous and say it is immoral to be anything else. In fact, this latent eruption of a repressed incestuous desire becomes an obligation, which is very much in line with the teachings of psychoanalysis; namely, that a repressed desire becomes the basis of a compulsion, in this case of an imposed institution, which it would be difficult to explain sociologically. Of course, these incestuous obligations, as you might call them, do not go as far as a father-son relation, but it seems to me that the *tchamadoong* system is so close to such a relation that again it could easily be explained in this way.

In the final instance, as I say, polyandry "persists through isolation, in the case of the Tibetans, and as part of a defense mechanism in the case of the Todas." The Tibetans are very isolated and do not come in contact with other peoples and, for that reason, the system is well preserved, though in the border region it is breaking down. I was much struck by the fact that people there do not like mentioning polyandry. They are shy about it and think it does not sound very nice to other people, while as one gets into the interior among real polyandrous people they are very proud of it and boast of it. In the case of Tocktock, which I mentioned before, the old man was surprised that other peoples were not polyandrous. As far as the Todas are concerned, they are cooped up in the mountains. They are hemmed in by other peoples who have other customs, but they still feel that they are the people of the Nilghiris, and that they are a superior race. In order to assert this, they stick very "nationalistically" to their customs, and I think polyandry persists among them as one of the symbols of their superiority.

I hope that this explanation of polyandry may sound convincing in spite of its mainly psychoanalytical approach. I think that the results of this first expedition were satisfactory, and thoroughly justify the desire for a second expedition to find out more about it, for there are many gaps that still need to be filled in, in order to complete the picture.

CONFERENCES HELD

SECTION OF OCEANOGRAPHY AND METEOROLOGY

CONFERENCE ON "OCEAN SURFACE WAVES": MARCH 18 AND 19, 1948

The Section of Oceanography and Meteorology held a Conference on "Ocean Surface Waves." Doctor Bernhard Haurwitz, New York University, New York, N. Y., was the Conference Chairman in charge of the meeting.

The program consisted of the following papers:

Thursday, March 18

Morning Session. "The Solitary Wave and Periodic Waves in Shallow Water," by Joseph B. Keller, Institute for Mathematics and Mechanics, New York University, New York, N. Y.

"The Action of Floating Bodies on Ocean Waves," by Fritz John, Institute for Mathematics and Mechanics, New York University, New York, N. Y.

"Breaking of Waves in Shallow Water," by James J. Stoker, Jr., Institute for Mathematics and Mechanics, New York University, New York, N. Y.

"Application of Solitary Wave Theory to Surf Problems," by Walter H. Munk, The Scripps Institution of Oceanography, La Jolla, California.

Afternoon Session. Chairman, G. E. R. Deacon, F.R.S., Admiralty Research Laboratory, Teddington, Middlesex, England.

"Wave Motion at the Surface of a Current which has an Exponential Distribution of Vorticity," by A. J. Abdullah, Massachusetts Institute of Technology, Cambridge, Massachusetts.

"Determination of the Depth of an Underwater Explosion from Measurements of the Dome of Spray," by C. L. Pekeris, Department of Applied Mathematics, The Weizmann Institute, Rehovoth, Palestine.

"Notes on Surface Waves," by Maurice Ewing and Frank Press, Department of Geology, Columbia University, New York, N. Y.

"The Propagation of Small Surface Disturbances Through a Non-Potential Flow," by P. D. Thompson, Institute for Advanced Study, Princeton, N. J.

Friday, March 19

Morning Session. Chairman, Roger Revelle, Office of Naval Research, Navy Department, Washington, D. C.

"Recent Studies of Waves and Swell," by G. E. R. Deacon, Admiralty Research Laboratory, Teddington, Middlesex, England.

"Some Results of Analyses of Sea Surface Roughness in the Western North Atlantic," by H. R. Seiwell, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

"The Comparison of Forecast and Recorded Waves on the Pacific Coast," by J. D. Isaacs and Thorndike Saville, Jr., University of California, Berkeley, California (read by M. P. O'Brien).

"Variability in Direction of Wave Travel," by R. S. Arthur, Scripps Institution of Oceanography, La Jolla, California.

Afternoon Session. Chairman, Columbus O'D. Iselin, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

"Naval Application of Wave Research," by A. C. Vine and Roger Revelle, Navy Department, Washington, D. C.

"Ocean Wave Research and its Engineering Applications," by Martin A. Mason, Beach Erosion Board, Army Engineers, Washington, D. C.

"Details of Shore-Based Wave Recorder and Ocean Wave Analyzer," by Arthur A. Klebba, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

"Utilization of Wave Forecasting in the Invasions of Normandy, Burma, and Japan," by Charles C. Bates, U. S. Navy Hydrographic Office, Washington, D. C.

NEW MEMBERS

Elected March 25, 1948

SUSTAINING MEMBERSHIP

Levine, Emanuel, M.Ed., Paleobotany, Paleozoology. Professor of Biology, Rider College, Trenton, N. J.

Vacquier, Victor, M.A., Geophysics, Instrumentation. Research Engineer, Sperry Gyroscope Co.; Research Associate, Geology Department, Columbia University, New York, N. Y.

Youngstein, Max E., M.L., Medical Motion Pictures. Vice President in Charge of Advertising, Publicity, and Exploitation, Eagle Lion Films, New York, N. Y.

ACTIVE MEMBERSHIP

Aloysius, M., M.A. Instructor, Biology, Chemistry, College of New Rochelle, New Rochelle, N. Y.

Badian, Albert A., Sound, Time, and Temperature Controls. Factory Manager, Comet Slide Fastener, Inc.; Treasurer, Seaboard Engineering Co., New York, N. Y.

Baum, Sidney J., M.A. Production Manager, Sterile Solutions, Endo Products, Richmond Hill, L. I., N. Y.

Benjamin, Bernard, M.D. Assistant Professor of Clinical Pediatrics, Long Island College of Medicine, Brooklyn, N. Y.

Bennett, Harry, B.S. Technical Director, Glyco Products Co., Inc., New York, N. Y.

Benson, Sidney W., Ph.D. Assistant Professor, Department of Chemistry, University of Southern California, Los Angeles, Calif.

Braham, Stanley B., M.D. Interne, Mt. Sinai Hospital, New York, N. Y.

Chase, Richard G., Ph.D. Chemist, Merck & Co., Inc., Rahway, N. J.

Chevigny, Hector, B.A., Psychology. New York, N. Y.

Coss, James A., Jr., M.D., Arthritic and Rheumatic Diseases. Assistant, Medicine, Columbia University, New York, N. Y.

Cramer, Frank B., Jr., B.A. Research Fellow, Experimental Medicine, Los Angeles County General Hospital, Los Angeles, Calif.

Doering, William, Ph.D. Assistant Professor, Organic Chemistry, Columbia University, New York, N. Y.

Evans, John D., Ph. D. Fellow, Physiology, Cornell University Medical College, New York, N. Y.

Finley, Harold E., Ph.D. Professor of Zoology, Head of Department, Howard University, Washington, D. C.

Friedman, Leo, M.S. Biochemist, Vitamin Division, U. S. Food & Drug Administration, Washington, D. C.

Friedman, Paul, M.D., Ph.D. Associate in Neuropsychiatry, Beth Israel Hospital, New York, N. Y.

Fuente, Victorino de la, M.D. Chief, Section on Hematology, University of Santo Tomas Medical School, Santo Tomas; Clinical Pathologist, Singian Clinic, Manila, Philippines.

Glass, George B. J., M.D. Clinical Assistant Visiting Physician, Metropolitan Hospital, New York, N. Y.

Glick, Arthur W., M.D. Adjunct Dermatologist, Mt. Sinai Hospital, New York, N. Y.

Gorin, Edward F., B.S. Medical Student, Long Island College of Medicine, Brooklyn, N. Y.

Gurd, Fraser N., M.D. Lecturer in Surgery, McGill University, Montreal, Canada.

Halpern, Seymour L., M.D. Resident, Montefiore Hospital, New York, N. Y.

Hassid, William Z., Ph.D. Professor of Plant Nutrition, Division of Plant Nutrition, University of California, Berkeley, Calif.

Irwin, John H., M.D. Attending Surgeon, Englewood Hospital, Englewood, N. J.

Jackson, Harold R., Firearms and Bladed Weapons. New York, N. Y.

Jackson, Raymond S., M.D. Instructor, Internal Medicine, University Hospital, Ann Arbor, Mich.

Kapp, Roland, Ph.D. Manager, Fine Chemicals Division, Nopco Chemical Co., Harrison, N. J.

Krasner, Leonard, M.S. Clinical Psychology Interne, Veterans Administration; Ph.D. Candi late, Columbia University, New York, N. Y.

Leeds, William G. Medical Student, Long Island College of Medicine, Brooklyn, N. Y.

Lefkowitz, Arnold, P.E., Structural Design and Metallurgy. Chief Engineer, Treasurer, North American Iron & Steel Co., Inc., Brooklyn, N. Y.

Levine, Celia, M.A. Graduate Student, Department of Biochemistry. Columbia University, New York, N. Y.

Levitt, Leon M., M.D. Assistant, Medicine, Long Island College of Medicine, Brooklyn, N. Y.

Lewis, Mary N., B.A. Pharmacologist, Warner Institute for Therapeutic Research, New York, N. Y.

Liebman, Philip. Associate, Biochemistry, Hematology, Coney Island Hospital, Brooklyn, N. Y.

Lief, Philip A., M.D. Research Resident in Anesthesiology, Goldwater Memorial Hospital, New York, N. Y.

McCormack, Robert B., Ph.D., Antibiotics. Assay Method Development, E. R. Squibb & Sons, New Brunswick, N. J.

Macgregor, Frances C., M.A., Sociology, Anthropology. Research Fellow, Manhattan Eye and Ear Hospital, New York, N. Y.

Marinaro, Armand, B.S. Head, Microbiology Laboratory, Biochemical Division, Interchemical Corp., Union, N. J.

Modell, Walter, M.D. Instructor, Pharmacology, Cornell University Medical College, New York, N. Y.

Pan, Shih-Yi, M.D. Instructor, Pharmacology, Columbia University, New York, N. Y.

Paul, Henry E., Ph.D. Head, Biological Division, Eaton Laboratories, Norwich, N. Y.

Pincus, Joseph B., M.D., Biological Chemistry. Attending Pediatrician, Department of Pediatrics, Jewish Hospital, Brooklyn, N. Y.

Pope, Alfred, M.D. Research Associate, Neuropathology, McLean Hospital, Waverley, Mass.

Roesch, Philip K., M.A., Nutrition. Research Associate, Lederle Laboratories Division, American Cyanamid Co., Pearl River, N. Y.

Roston, Edward H., M.D. Resident, Physiology, Mt. Sinai Hospital, New York, N. Y.

Rudolph, Irving, M.D. Assistant Pathologist, Coney Island Hospital, Brooklyn, N. Y.

Schatz, Albert, Ph.D., Protistology. Assistant, Sloan-Kettering Institute for Cancer Research, New York, N. Y.

Seaton, Stuart L., B.S., Upper Atmospheric Physics. Director, Geophysical Observatory, University of Alaska, College, Alaska.

Selikson, Bernard, M.S. Teaching Fellow, Department of Chemistry, New York University, New York, N. Y.

Sigel, M. Michael, Ph.D. Associate, Virology, Department of Pediatrics, University of Pennsylvania, School of Medicine, Philadelphia, Pa.

Stumbo, Charles R., Ph.D. Chief, Bacteriological Section, Central Research Department, Food Machinery Corp., San Jose, Calif.

Vollmer, Erwin P., Ph.D., Endocrinology, Epidemiology. Physiologist, Naval Medical Research Institute, Bethesda, Md.

Wells, Roe E., M.D. Pharmacologist, Medical Division, Army Chemical Center, Md.

Wendler, Norman L., Ph.D. Research Chemist, Merck & Co., Inc., Rahway, N. J.

Zaiser, Ethel M., Ph.D. Research Associate, Physical Chemistry, Massachusetts Institute of Technology, Cambridge, Mass.

Zak, Emil R., M.D. Adjunct Attending in Internal Medicine; Assistant Adjunct Attending in Cardiology, Beth David Hospital, New York, N. Y.

Zucker, Lois M., Ph.D. Research Associate, Department of Pathology, College of Physicians & Surgeons, Columbia University, New York, N. Y.

STUDENT MEMBERSHIP

Khan, Paul, B.A., Biology, Boderiology. Student, New York University, New York, N. Y.

Schayer, Richard W., B.S. Graduate Student, Biochemistry, Columbia University, New York, N. Y.

Schreiman, Evelyn S., B.A., Biology. Teaching Assistant, Newark College, Rutgers University, Newark, N. J.